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MPDA-1:

A METEOROLOGICAL PROCESSOR FOR DIFFUSION ANALYSIS

User's Guide

by

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16. ABSTRACT

Version I of the Meteorological Processor for Diffusion Analysis (MPDA-1) is a first attempt to provide a processor that can organize available meteorological data into a format accessible to diffusion analysis. MPDA-1 provides methods for preparing three types of data: National Weather Service (NWS) twice-daily radiosonde reports, NWS hourly surface observations, and user-supplied on-site data. To incorporate the surface scaling parameters, the meteorological processor is structured in accordance with current concepts of the idealized states of the planetary boundary layer. Profiles of wind velocity, temperature, and the standard deviations of vertical and lateral wind velocity fluctuations at user-specified heights are estimated. The output from MPDA-1 was formatted to accomodate the TUPOS Gaussian-plume model, which uses wind fluctuation data to characterize the diffusion parameters. Future versions will provide additional output formats to accomodate other popular diffusion estimation models.

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AFFILIATION

Mr. John S. Irwin is on assignment from the National Oceanic and Atmospheric Administration, U.S. Department of Commerce.

PREFACE

One area of research within the Meteorology and Assessment Division is development, evaluation, validation, and application of models for air quality simulation, photochemistry, and meteorology. The models must be able to describe air quality and atmospheric processes affecting the diffusion of airborne pollutants on scales ranging from local to global. Within the Division, the Environmental Operations Branch adapts and evaluates new and existing meteorological diffusion models and statistical technique models, tailors effective models for recurring user application, and makes these models available through EPA's UNAMAP system.

This user's guide is intended to be a continually evolving document that will be updated as changes and additions are made. Each page of this document has a month and a year typed in the lower right-hand corner. Future revisions to this document will be indicated in the preface, and every page that is changed will have a new date printed in the lower right-hand corner. Revisions may be obtained as they are issued by completing and returning the form on the last page of this guide.

Comments and suggestions regarding this publication should be directed as follows:

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Technical questions regarding use of the MPDA-1 may be asked by calling 919/541-4564. Users within the Federal Government may call FTS 629-4564. Copies of this document are available from the National Technical Information Service, Springfield, VA 22161.

ABSTRACT

Version 1 of the Meteorological Processor for Diffusion Analysis (MPDA-1) is a first attempt to provide a processor that can organize available meteorological data into a format accessible to diffusion analysis. MPDA-1 provides methods for preparing three types of data: National Weather Service (NWS) twice-daily radiosonde reports, NWS hourly surface observations, and user-supplied on-site data. To incorporate the surface scaling parameters, the meteorological processor is structured in accordance with current concepts of the idealized states of the planetary boundary layer. Profiles of wind velocity, temperature, and the standard deviations of vertical and lateral wind velocity fluctuations at user-specified heights are estimated. The output from MPDA-1 was formatted to accomodate the TUPOS Gaussian-plume model (Turner *et al.*, 1985), which uses wind fluctuation data to characterize the diffusion parameters. Future versions will provide additional output formats to accomodate other popular diffusion estimation models.

CONTENTS

Preface iii
Abstract iv
Figures viii
Tables xi
Acknowledgments xiii

1. Introduction 1-1
    Purpose 1-1
    History 1-1
    Features and Limitations 1-3
2. Overview 2-1
    Preprocessor. 2-2
        SCAN 2-4
        EXTRACT 2-4
        CONVERT 2-4
        QA 2-4
        REDUCE 2-5
        HRLY-INTERP. 2-5
        MERGE 2-5
    Metprocessor 2-6
3. Technical Description of Algorithms 3-1
    Introduction 3-1
    Surface Roughness Length 3-2
        ZOMOD1 3-4
        ZOMOD2 3-4
    Surface Friction Velocity, Surface Sensible Heat Flux, and the Monin-Obukhov Length 3-5
        HMOD1 and USMOD1 3-5
        HMOD3 and USMOD3 3-6
    Mixing Height 3-11
        ZCMOD2 and ZMMOD1 3-12
        ZCMOD1 3-14
        ZMMOD2 3-15
    Heights 3-16
    Temperature Profiles 3-16
        TMOD1 3-17
    Wind Profiles 3-18
        UVMOD2 3-19
        UVMOD3 3-21
        UVMOD4 3-22
    Turbulence Profiles 3-24
        SWMOD1 and SVMOD1 3-24
        SWMOD2 and SVMOD2 3-25

4. Technical Guidance for Input Data 4-1
  - Introduction 4-1
  - ATAPE 4-2
  - Preprocessor 4-4
    - Radiosonde Data Pathway 4-4
    - Surface Observation Data Pathway 4-13
    - On-Site Data Pathway 4-18
    - MERGE 4-24
  - Metprocessor 4-25
    - The Program 4-25
    - Input Card Image and File Format Requirements 4-25

5. Sample Problem 5-1
  - Introduction 5-1
  - Radiosonde Data Pathway 5-2
    - SCAN-UPPR 5-3
    - EXTRACT-UPPR 5-4
    - CONVERT-UPPR 5-6
    - QA-UPPR 5-8
    - REDUCE 5-12
    - HRLY-INTERP 5-14
  - Surface Observation Data Pathway 5-16
    - SCAN-SFC 5-17
    - EXTRACT-SFC 5-18
    - CONVERT-SFC 5-20
    - QA-SFC 5-23
  - On-Site Data Pathway 5-26
    - QA-SITE 5-27
  - MERGE 5-31
  - Metprocessor 5-35
  - User Checklists 5-39

6. Technical Aspects of the Preprocessor 6-1
  - EXTRACT-UPPR 6-1
  - QA-UPPR 6-1
  - HRLY-INTERP 6-4
  - QA-SFC 6-5
  - QA-SITE 6-6
  - MERGE 6-7

7. Computer Aspects of the System 7-1
  - Introduction 7-1
  - Problems with Executing the System 7-3
    - Nonstandard FORTRAN 7-3
    - Configuration of MPDA Files on the NTIS Tape 7-5
  - Structure of the Metprocessor 7-9
    - Driver 7-15
    - Accessing the Methods of Calculation 7-16
    - The Subroutines 7-17
  - Adding Methods 7-19

References R-1

Appendices

A. Computation of the Solar Elevation Angle A-1
B. Computation of the Critical Solar Elevation Angle B-1
C. File Format Requirements for Mid-Sequence Programs . . . C-1
D. Output File Format From OUT4 . . . . D-1
E. Error Messages E-1
F. Subroutines Used in the Preprocessor F-1

FIGURES

Number Page

2.1 Data flow in the metprocessor 2-1

2.2 Program flow for the preprocessor 2-2

2.3 Program flow in the metprocessor 2-8

3.1 Weighting function, f_s, for wind speed and direction 3-21

3.2 Weighting function, f_s, for (a) wind direction and (b) wind speed 3-23

4.1 The radiosonde data pathway in the preprocessor 4-6

4.2 The surface observation data pathway in the preprocessor . . 4-13

4.3 The on-site data pathway in the preprocessor 4-18

5.1 The radiosonde data pathway 5-2

5.2 Runstream for SCAN-UPPR 5-3

5.3 Report from SCAN-UPPR 5-3

5.4 Runstream for EXTRACT-UPPR 5-4

5.5 Sample of output file from EXTRACT-UPPR 5-5

5.6 Runstream for CONVERT-UPPR 5-6

5.7 Sample of output file from CONVERT-UPPR 5-7

5.8 Runstream for QA-UPPR 5-8

5.9 Limits and options for QA-UPPR 5-8

5.10 Partial list of QA-UPPR violations on the first pass through the data 5-10

5.11 Sample of output file from QA-UPPR 5-11

5.12 Runstream for REDUCE 5-12

5.13 Sample of output file from REDUCE 5-13

5.14 Runstream for HRLY-INTERP 5-14

Number | Page
5.15 Sample output file from HRLY-INTERP 5-15
5.16 The surface observation data pathway 5-16
5.17 Runstream for SCAN-SFC 5-17
5.18 Report from SCAN-SFC 5-17
5.19 Runstream for EXTRACT-SFC 5-18
5.20 Sample of output file from EXTRACT-SFC 5-19
5.21 Runstream for CONVERT-SFC 5-20
5.22 Sample of output file from CONVERT-SFC 5-21
5.23 Sample of the report file for CONVERT-SFC 5-22
5.24 Runstream for QA-SFC 5-23
5.25 List of options and limits for QA-SFC 5-24
5.26 QA-SFC report of violations 5-24
5.27 Sample of output file from QA-SFC 5-25
5.28 The on-site data pathway 5-26
5.29 Runstream for QA-SITE 5-27
5.30 QA-SITE limits and options 5-28
5.31 QA-SITE report of violations 5-29
5.32 Sample of output file for QA-SITE 5-30
5.33 Runstream for MERGE 5-31
5.34 Sample of report file produced by MERGE 5-32

Number Page

5.35 Runstream for the metprocessor 5-35

5.36 Sample of error messages produced by the metprocessor 5-36

5.37 Sample of descriptive output file produced by the metprocessor 5-37

7.1 COMMON blocks and declarative statements as they appear in the source code 7-11

7.2 The primary functions of DRIVER and their relation to its structure 7-15

7.3 Design of the subroutines for the methods of calculation in the metprocessor 7-17

TABLES

Number Page

1.1 Design criteria for the MPDA-1 1-4

3.1 Choices of subroutines containing methods of calculation for parameters and profiles in the metprocessor 3-1

3.2 Terrain classification table 3-3

3.3 Typical values of α' and β' and conditions under which they occur 3-8

3.4 Coefficients for the incoming solar radiation and locations at which values were obtained or are valid 3-9

4.1 Input card image for SCAN-UPPR 4-7

4.2 Input card image for EXTRACT-UPPR 4-8

4.3 Input card image for CONVERT-UPPR 4-9

4.4 Number of time zones west of Greenwich, England 4-9

4.5 Input file of limits and options for QA-UPPR 4-11

4.6 Input card image for HRLY-INTERP 4-12

4.7 Input card image for REDUCE 4-12

4.8 Input card image for SCAN-SFC 4-14

4.9 Input card image for EXTRACT-SFC 4-15

4.10 Input file of CONVERT-SFC 4-16

4.11 Input file of limits for QA-SFC 4-17

4.12 Options and limits file format for QA-SITE 4-19

4.13 Variables evaluated by QA-SITE 4-20

4.14 Input file format for QA-SITE 4-21

4.15 Input card image for QA-SITE 4-23

4.16 Input card images for MERGE 4-24

Number Page

4.17 Input card image for the metprocessor 4-26

5.1 Radiosonde data pathway execution checklist 5-40

5.2 Surface observation data pathway execution checklist 5-41

5.3 On-site QA execution checklist 5-42

5.4 MERGE execution checklist 5-42

5.5 Metprocessor execution checklist 5-42

7.1 UNIVAC system specifications 7-2

7.2 Order of the UNIVAC program files and elements on the NTIS tape 7-7

7.3 Subroutines and PROCs required by the main programs 7-8

7.4 Choice of sets of constants used by the metprocessor 7-10

7.5 Installation checklist for producing executable code 7-20

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SECTION 1

INTRODUCTION

PURPOSE

The availability of many diffusion models, combined with the availability of new data sources, has created a need for a processor that can organize the available meteorological data into a format accessible to diffusion analyses. Version 1 of the Meteorological Processor for Diffusion Analysis (MPDA-1) is an attempt to fill this need.

HISTORY

Research has been conducted towards obtaining a better characterization of the diffusion of air pollutants and a better understanding of the meteorological variables of most concern to diffusion analyses. Most of the early popular attempts to estimate diffusion of air pollutants were based on the Gaussian-plume model (see Sutton, 1953; Slade, 1968; Stern, 1970). It was recognized that the only relevant measurements of wind fluctuations likely to be available for routine studies were those contained in conventional traces of horizontal wind direction. Pasquill (1961) gave simple rules for obtaining the lateral spread, based on wind-direction trace data. In the absence of such data, he suggested that the effects of thermal stratification in the lower atmosphere be represented in broad categories of stability, defined in terms of meteorological data routinely available in surface weather observations.

By the early 1970's, air quality simulation models were viewed as tools to estimate the relative magnitudes of pollutant concentration distributions from various sources, thus providing a rational basis for strategies of air quality improvement or maintenance. Most of the air quality simulation models developed in response to these modeling requirements were based on the general Gaussian-plume model. Gaussian-plume diffusion was estimated for each hour with hourly values of surface wind speed and direction, ambient air temperature, the Pasquill stability category, and mixing height. Typically, the wind direction was assumed to be constant with height. Some models provided for the variation of wind speed with height with a power-law approximation; the power-law exponent was specified as a function of Pasquill stability category. When temperature gradients were needed, as for the estimation of plume rise during stable stratification, values were assumed for each Pasquill category. It was further assumed that the diffusive characteristics of the atmosphere were vertically and horizontally homogeneous within the mixing layer.

Practical methods for characterizing the profiles of wind, temperature, and turbulence within the planetary boundary layer are now beginning to be developed. These methods are improving as new data are acquired and analyzed. In the next decade, measurement methods may develop to the point that frequent routine measurements of the structure of the planetary boundary layer may be made remotely by using Doppler-acoustic radars. Already, the capabilities of Doppler-acoustic radars to measure the vertical profiles of wind velocity have been reported by Hall et al. (1975), Balser et al. (1976), and Kaimal and Haugen (1977).

When these new methods of data acquisition are perfected, it may become possible to specify routinely the following meteorological data: mixing height, atmospheric stability, the profiles of the standard deviations of vertical and lateral wind velocity fluctuations, and the profiles of wind velocity and temperature. Availability of these data on an hourly basis has important implications for diffusion modeling. Standard deviations of wind-speed fluctuations can be used to characterize the sigmas in a Gaussian-plume model (Draxler, 1976; Irwin, 1979; 1983). These data will allow the improved algorithms to be used for estimating plume rise (Briggs, 1975) and wind direction shear effects (Pasquill, 1976), which have largely been ignored in routine modeling studies of diffusion. Also, these data will accommodate Monte-Carlo particle trajectory models of diffusion or grid models that use eddy diffusivities (see Hanna, 1982). The MPDA-1 has been designed to accommodate these new sources of data as well as data gathered by more traditional means.

FEATURES AND LIMITATIONS

MPDA-1 offers a set of methods for preparing three types of data for use in diffusion analysis: National Weather Service (NWS) twice-daily radiosonde reports, NWS hourly surface weather observations, and user-supplied on-site data. A selection of methods is available for estimating vertical profiles of wind velocity and temperature and the standard deviations of vertical and lateral wind velocity fluctuations. Procedures are also provided for estimating mixing height and surface scaling parameters, including the Monin-Obukhov length.

The main feature of MPDA-1 is its flexible design, which allows user interaction to improve the results. This is true for the preprocessor portion of the system, which prepares data for the metprocessor portion. It is also true for the metprocessor, which manipulates data according to the algorithms specified by the user. Each method for calculating a parameter or profile is a separate subroutine; the modular design adapts easily to changes in input data formats. The modular design is also used in the preprocessor. Thus, the user can enter the preprocessor at any point by using the correct input file format. The flexible design allows the system to accommodate any diffusion model. During the development of MPDA-1, output was formatted to accommodate the TUPOS (TUrbulence PrOfile Sigmas) diffusion model (Turner et al., 1985), but the system is not limited to TUPOS. Because each method computes only one surface parameter or constructs a profile, the user can easily add an alternative method for a parameter and use it in the computations, rather than one supplied with the system. The user is encouraged to submit any subroutines or algorithms that demonstrate improved accuracy or speed. The part of the preprocessor concerned with on-site data contains several variables that are not used in the MPDA-1. These variables are thus available to the user who develops his own metprocessor algorithms. The MPDA is a continually evolving system; user comments and suggestions are welcome.

MPDA-1 was developed with specific design criteria in mind. These criteria and the methods by which they were met are listed in Table 1.1. The criteria reflect the goal of creating a system with as much built-in flexibility as possible.

TABLE 1.1. DESIGN CRITERIA FOR THE METPROCESSOR

Need	Implementation
— New methods must be easily added; obsolete methods must be easily deleted.	— The computations associated with each method occur within individual subroutines; to add or delete a method, only a change in the main program is needed.
— The input data and results from computations must be readily accessible.	— The data are accessible to all subroutines in their entirety via COMMON blocks.
— The code must be standard for most computer systems.	— ANSI FORTRAN 77 was used to code the system.
— Must be able to vary output by parameters and style, depending on the requirements of the diffusion model.	— Output is generated by subroutines; thus, new output styles or variable lists can be easily added by adding subroutines.

At least one method for each parameter is provided, so that the system can be used even if only NWS upper air data and surface observations are available. The upper air data used during development of MPDA-1 were from NWS radiosondes collected at 0000 Greenwich Mean Time (GMT) and 1200 GMT. Because the MPDA-1 metprocessor requires hourly data, the soundings are interpolated to hourly values. Adding on-site data from multilevel instrumented towers or remote sensors would expand the number of usable methods available and improve the results for the lower part of the atmosphere.

As with any system, the MPDA-1 does have limitations. The system is easy to implement, but the user should note that certain methods require more sophisticated input data than are typically available in a routine weather observation. The user should specify methods that are compatible with the data available. For example, if on-site data are not available, then some of the methods cannot be fully utilized.

With these limitations in mind, the user will find the MPDA-1 to be a flexible and effective system for organizing meteorological data into a format accessible to diffusion analyses. A broad overview of the system and its components is found in Section 2.

SECTION 2

OVERVIEW

As can be seen in the data flow diagram in Figure 2.1, the MPDA-1 consists of a preprocessor and a meteorological processor (metprocessor), which can then be used by a diffusion model. The preprocessor can accommodate data collected by standard radiosondes, surface observations, and multilevel observations at special meteorological sites (on-site observations). The preprocessor prepares and combines the data from these three sources into one unformatted file for use by the metprocessor. The metprocessor estimates the surface scaling parameters and the profile variables. A selection of methods is available for determining most meteorological parameters; these options reflect differences in the theoretical derivations

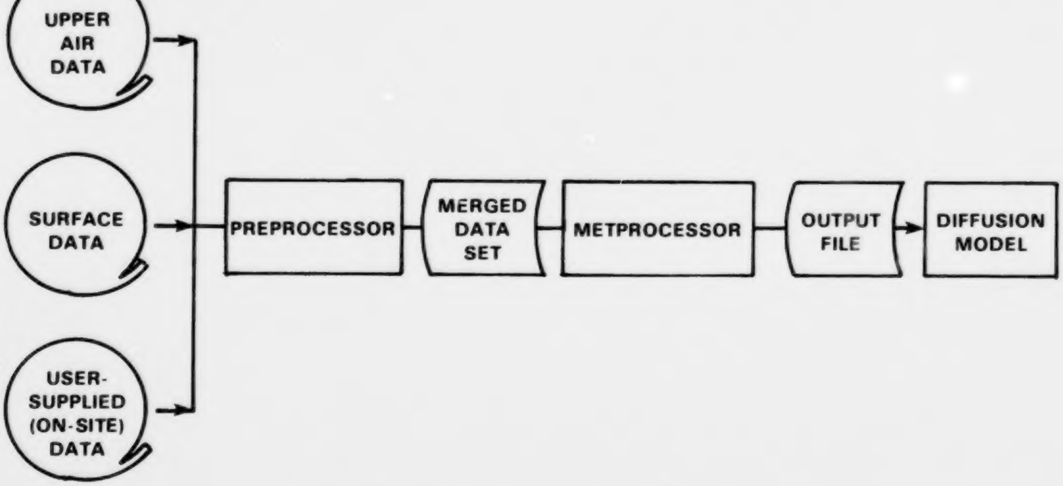
UPPER AIR DATA
SURFACE DATA
USER-SUPPLIED (ON-SITE) DATA
PREPROCESSOR
MERGED DATA SET
METPROCESSOR
OUTPUT FILE
DIFFUSION MODEL

Figure 2.1. Data flow in the MPDA-1.

of the algorithms. MPDA-1 produces the multilevel meteorological information required as input for diffusion algorithms such as TUPOS. TUPOS is a multiple point source Gaussian diffusion algorithm that uses on-site turbulence data. It uses standard deviations of hourly wind fluctuation to calculate plume spreading. For more information on TUPOS, see Turner et al., 1985.

PREPROCESSOR

The preprocessor consists of a series of programs that format meteorological data according to the specifications of the MERGE program

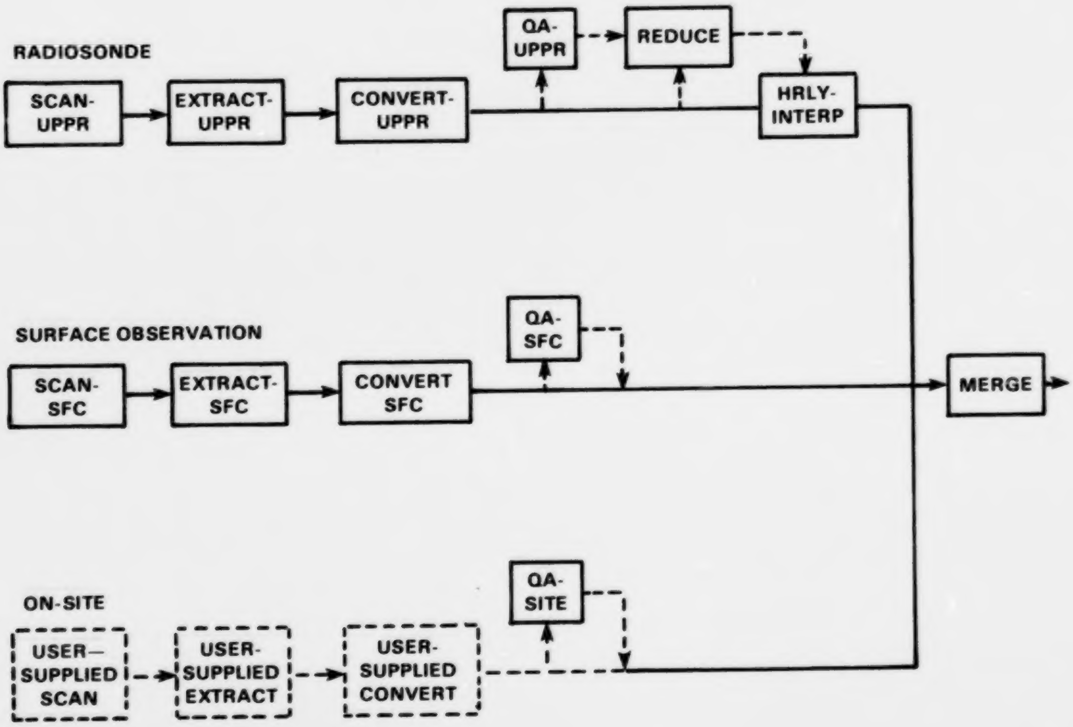
RADIOSONDE
SCAN-UPPR
EXTRACT-UPPR
CONVERT-UPPR
QA-UPPR
REDUCE
HRLY-INTERP
SURFACE OBSERVATION
SCAN-SFC
EXTRACT-SFC
CONVERT SFC
QA-SFC
MERGE
ON-SITE
USER—SUPPLIED SCAN
USER-SUPPLIED EXTRACT
USER-SUPPLIED CONVERT
QA-SITE

Figure 2.2. Program flow for the preprocessor. Dashed lines indicate optional pathways. Day-records containing data from all three sources are produced by MERGE for use by the metprocessor. Because of the wide variability of possible formats for on-site data, only a QA program is provided.

(Figure 2). The preprocessor can accommodate data from three sources: NWS radiosondes, NWS surface weather observations, and user-provided on-site observations.

A similar series of programs for each data source is used by the preprocessor. Radiosonde and surface observation data have routines associated with them to report the contents of a magnetic tape or disk file (SCAN), to extract data from a tape or file (EXTRACT), to convert data to different units or compute new variables (CONVERT), and to assess the quality of the data (QA). A routine to reduce the number of levels of data (REDUCE) and a routine to interpolate radiosonde reports of any time interval (up to 12 h) to hourly reports (HRLY-INTERP) are also available for radiosonde data as options. Because of the variability that may exist in the on-site data format, the preprocessor only contains a QA program for on-site data.

The programs in the preprocessor were developed specifically for standard NWS radiosonde and surface observation data. The data are available from the National Climatic Data Center (NCDC) in Asheville, North Carolina. The preprocessor uses radiosonde data in NCDC's TD-56 VAR format, and the surface observations are in the CD144 format. We understand these formats are being revised, so the user may wish to contact NCDC at the address and phone number given in Section 4. Further details on NCDC's formats may also be found in Section 4.

The type of meteorological data available will dictate which programs in the preprocessor will be used. For example, if no radiosonde data are available, all of the radiosonde preprocessor routines can be skipped, but an empty file must be created for MERGE to use. If the user's data have already been extracted and quality-assessed, only the CONVERT programs may be needed, because they prepare the data in the format required by MERGE. The programs in the preprocessor are described briefly below.

SCAN

These programs scan the tapes containing raw input data and produce a list of stations and dates recorded on the tape. The output report is not used as input to any other programs.

EXTRACT

These programs extract data for the desired time period from the raw input data tapes. The user provides the range of dates of interest by specifying Julian beginning and ending dates, the station identification code and its latitude and longitude. The specified raw data are extracted from the tapes and produced as output files.

CONVERT

These programs perform two functions.

1. They reformat the output files to comply with the format specifications of the MERGE program. All programs after CONVERT use the same format.
2. They convert variables to the set of units required by the metprocessor.

QA

QA programs are available for all three data types. Execution of these programs is optional. The output files created by the CONVERT programs meet the format requirements of the QA programs as well as those for MERGE. The QA programs for radiosonde and surface observation data scan the data sets for values that do not satisfy the criteria specified by the user. The QA program for on-site data gives the user a choice between specifying acceptable ranges for all variables measured or using default values.

All programs generate reports of values that do not satisfy the assessment criteria. The user may choose to change the indicated values, or leave them as they are.

REDUCE

Because radiosondes extend to heights considerably greater than those required by most diffusion models, the reduction program deletes data above a user-specified height in each report. This routine also has a user-specified option to adjust all the heights of the sounding from above mean sea level to above ground level (AGL). The metprocessor requires heights to be specified as AGL.

HRLY-INTERP

If the time interval between soundings is greater than 1 h, this interpolation program must be used to prepare the data in the hourly format required by MERGE. The user specifies the range of dates over which interpolation is required, and the program linearly interpolates the data over time. The output file generated contains hourly radiosonde data for the specified date range.

MERGE

MERGE combines the three output files of the preprocessor (radiosonde, surface observation, and on-site data) into one unformatted (binary) file for use by the metprocessor. The result is a sequence of unformatted day-records. A day-record consists of one 24-h day of output, with 24 hourly observations of radiosonde, surface, and on-site data.

Before executing MERGE, the three data files must be in hourly intervals and ordered sequentially by local standard time (LST). The preprocessor can prepare any or all of the files for MERGE. However, the preprocessor does not have to be used to prepare the data, as long as the format specifications for MERGE are met. In addition to the unformatted output file used by the metprocessor, MERGE will also generate a formatted output file if the user requests it.

METPROCESSOR

The metprocessor uses data combined by MERGE to calculate the meteorological parameters required by diffusion models. Estimates of the fundamental surface scaling parameters (including surface fluxes and Monin-Obukhov length), surface roughness length, and mixing height are determined first. This is followed by estimates of wind velocity, temperature, and standard deviations of the horizontal and vertical wind speed fluctuations at heights specified by the user. Methods are available that require only NWS radiosonde and surface observation data to estimate all the variables. Other methods are available that incorporate on-site data to estimate variables.

The metprocessor consists of a main program and a series of subroutines that calculate the individual parameters and construct profiles. It also contains subroutines that do not calculate the parameters or profiles themselves, but are necessary for those calculations. These include the solar elevation angle, the surface layer similarity functions, and the interpolation subroutines. Output subroutines are also available.

Features of the metprocessor include the following:

1. Choice of two or more methods to compute most parameters;
2. Choice of similarity constants: Dyer and Hicks (1970) or Businger, _et al_. (1971);
3. Choice of similarity theory computations for a stable atmosphere;

4. Inclusion of the effects of multiple terrain types on surface roughness;
5. Heights at which variables are computed can be entered as height above the surface or as fractions of the mixing height;
6. Up to 20 heights of data can be produced, with that number easily modified in the code, if necessary.

The metprocessor processes one day-record (24-h record) from MERGE at a time. All data are in local standard time. Because processing is day-by-day, information from the previous day is unavailable for computation during the current day. This limitation must be considered if the user adds additional subroutines. After all the hours of one day-record are processed, DRIVER begins processing the next day-record. Only one method for calculating a parameter is allowed per run. Subroutines listed in the order in which variables must be computed are given in Figure 2.3, which illustrates program flow in the metprocessor.

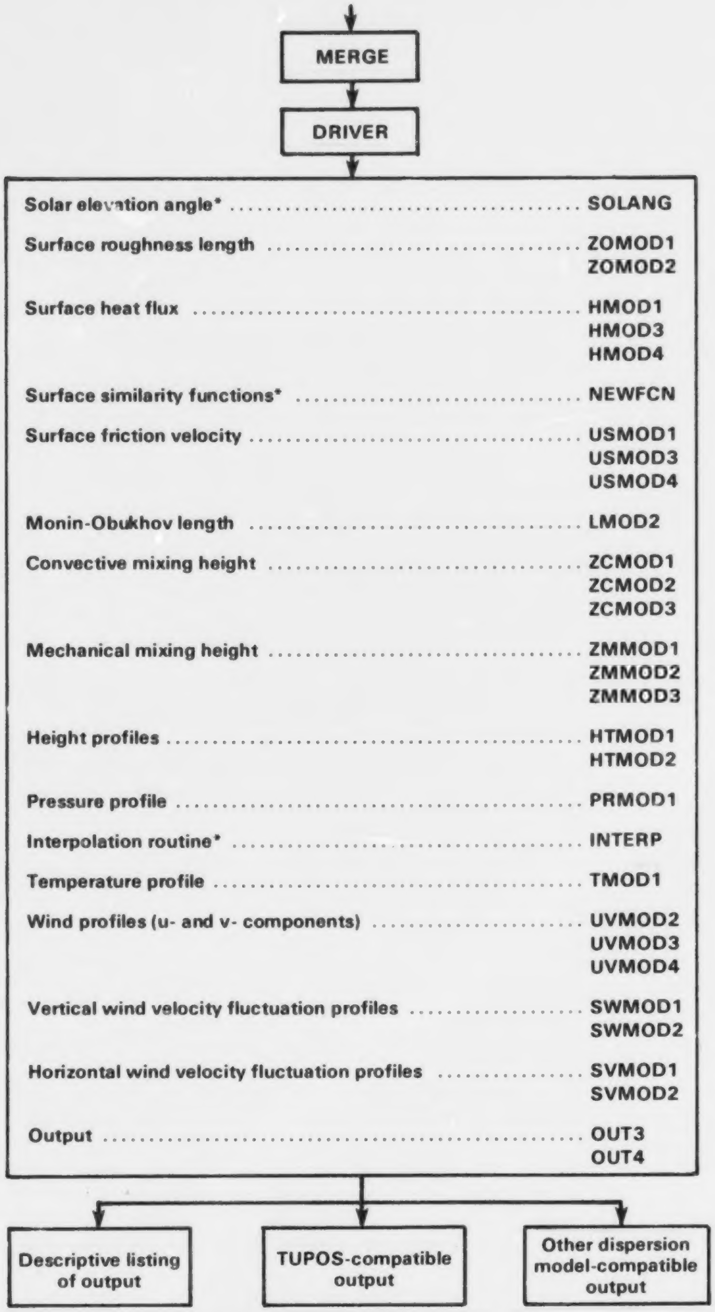
MERGE
DRIVER
Solar elevation angle* SOLANG
Surface roughness length ZOMOD1 ZOMOD2
Surface heat flux HMOD1 HMOD3 HMOD4
Surface similarity functions* NEWFCN
Surface friction velocity USMOD1 USMOD3 USMOD4
Monin-Obukhov length LMOD2
Convective mixing height ZCMOD1 ZCMOD2 ZCMOD3
Mechanical mixing height ZMMOD1 ZMMOD2 ZMMOD3
Height profiles HTMOD1 HTMOD2
Pressure profile PRMOD1
Interpolation routine* INTERP
Temperature profile TMOD1
Wind profiles (u- and v- components) UVMOD2 UVMOD3 UVMOD4
Vertical wind velocity fluctuation profiles SWMOD1 SWMOD2
Horizontal wind velocity fluctuation profiles SVMOD1 SVMOD2
Output OUT3 OUT4
Descriptive listing of output
TUPOS-compatible output
Other dispersion model-compatible output

Figure 2.3. Program flow in the metprocessor. Variables must be computed in the order listed. Subroutine descriptions followed by an asterisk are secondary programs that do not compute variables. NEWFCN and INTERP are listed at the point at which they are first used; other subsequent subroutines also use them. Only one subroutine per variable may be executed per run.

SECTION 3

TECHNICAL DESCRIPTION OF ALGORITHMS

INTRODUCTION

This section outlines methods to estimate the wind, temperature, and turbulence profiles from hourly meteorological data. The surface layer scaling parameters are described first, because they are used in subsequent methods. Next, the daytime and nighttime mixing heights are discussed. This is followed by methods for constructing the wind, temperature, and turbulence profiles. The user's choices for a method of calculation for each of the parameters and profiles are listed in Table 3.1. Each method is encoded as a separate subroutine.

TABLE 3.1. CHOICES OF SUBROUTINES CONTAINING METHODS OF CALCULATION FOR PARAMETERS AND PROFILES IN THE METPROCESSOR

Parameter or Profile	Subroutine Name	Description
Surface roughness length, z_0 (m)	ZOMOD1	Roughness length estimated from user-defined land-use and terrain types.
	ZOMOD2	User-specified value, or if unavailable, a default value of 0.3 m.
Surface heat flux, H_0 (W/m^2) and Surface friction velocity, u_* (m/s)	HMOD1 and USMOD1	Heat flux estimated using surface layer similarity theory and low-level profile data of wind speed and temperature difference.
	HMOD3 and USMOD3	Parameterization of surface energy fluxes in terms of standard weather observations of cloud cover, temperature, and near-surface wind speed and surface roughness length (z_0).
	HMOD4 and USMOD4	User-supplied values from on-site data. If an hourly value is missing, the method defaults to HMOD3/USMOD3.
Monin-Obukhov length (m)	LMOD2	Direct computation using H_0 and u_*
Convectively driven mixing height (m)	ZCMOD1	Rate equation for a zero-order jump model coupled with a free convection formula.
	ZCMOD2	Intersection of the sunrise radiosonde report with the dry adiabat corresponding to the hourly surface temperature.
	ZCMOD3	User-supplied value from on-site data. If an hourly value is missing, the method defaults to ZCMOD1.

continued

TABLE 3.1. CHOICES OF SUBROUTINES CONTAINING METHODS OF CALCULATION FOR PARAMETERS AND PROFILES IN THE METPROCESSOR (CONTINUED)

Parameter or Profile	Subroutine Name	Description
Mechanically driven mixing height (m)	ZMMOD1	$z_m \alpha u_*/f$, where f is the Coriolis parameter.
	ZMMOD2	Daytime: $z_m \alpha u_*/f$ Nighttime: $z_m \alpha (u_*/f)/(1 + 1.9 z_m/L)$
	ZMMOD3	User-supplied value from on-site data. If an hourly value is missing, the method defaults to ZMMOD2.
Heights (m)	HTMOD1	User-specified.
	HTMOD2	User-supplied fractions of mixing height.
Temperature profile (°C)	TMOD1	Assumes constant potential temperature below the daytime convective mixing height; below the nighttime surface-based inversion height, potential temperature $\alpha(1 - z/h_i)^3$.
Wind velocity profile (m/s)	UVMOD2	Weighted average of wind velocity profiles estimated from similarity theory and determined from radiosonde reports.
	UVMOD3	Interpolated from user-supplied wind profile data. When data are missing or insufficient, the method defaults to UVMOD2.
	UVMOD4	Same as UVMOD2, except that linear weighting functions are used. The weights for wind speed and wind direction are treated separately.
Vertical and horizontal wind velocity fluctuations (variances) (m/s)	SWMOD1 and SVMOD1	Estimated from empirical parameterizations using h_m, u_*, and convective scaling velocity.
	SWMOD2 and SVMOD2	On-site values of the variances are used as correction factors to estimates made by SWMOD1 and SVMOD1.

SURFACE ROUGHNESS LENGTH

The surface roughness length (z_0) is related to the roughness characteristics of a homogeneous terrain and is, in principle, the height at which the wind speed is zero. Under near-neutral conditions and with a homogeneous distribution of obstacles, a local value of z_0 can be determined from the logarithmic wind profile. However, the logarithmic profile applies only far away from the individual obstacles ($z/z_0 \gg 1$). Davenport (1960) demonstrated a systematic relationship between ground roughness and vertical gradients of the wind by relating generalized terrain classifications to the exponent in the power-law wind profile. Wieringa (1980) adapted this scheme to relate terrain classes to the surface roughness length (Table 3.2).

TABLE 3.2. TERRAIN CLASSIFICATION TABLE*

Type	Description	Value of z_0 (m)
1	Smooth, open sea, fetch at least 5 km	0.0002
2	Land, no obstacles	0.005
3	Open flat terrain; grass, few isolated obstacles	0.03
4	Low crops; occasional large obstacles	0.10
5	High crops; scattered obstacles	0.25
6	Bushes, numerous obstacles	0.50
7	Regular large obstacles	1.00
8 (unused)	Center city	—

* Source: Wieringa (1980).

The area surrounding a site is generally not composed of a homogeneous distribution of a single surface feature, due to variations of the terrain and land use. The wind profile is influenced by the cumulative effects of surface obstacles (Davenport, 1960), and surface roughness tends toward the roughness of the roughest obstacles (van Dop et al., 1982). Fiedler and Panofsky (1972) introduced the concept of an effective roughness length over heterogeneous terrain. The effective roughness length represents a larger area and yields a more characteristic surface friction velocity for the area. If there are large differences in terrain and land use, an effective roughness length could be determined from an average of roughness lengths corresponding to the most dominant features. However, large variations frequently occur, and roughness length cannot be linearly averaged. Smith and Carson (1977) related the neutral atmosphere equivalent geostrophic drag coefficient at 10 m to the roughness length, which was adapted by van Dop *et al*. (1982) in the following form:

$$C_D = [k/\ln(10/z_0)]^2, \quad (3.1)$$

where k is the von Karman constant. The drag coefficient varies much less than the roughness length and can be averaged linearly over an area.

To compute an average roughness length over heterogeneous terrain, the three most dominant terrain features of the surrounding area in the upwind direction are identified (Table 3.2), and drag coefficients are computed for each class from (3.1). An average drag coefficient is computed by using the following equation:

$$\overline{C}_D = f_1 C_{D1} + f_2 C_{D2} + f_3 C_{D3}, \quad (3.2)$$

where f_1, f_2, and f_3 are weighting factors, with $f_1 + f_2 + f_3 = 1.0$, and the most dominant feature is most heavily weighted. Finally, the average roughness length is computed with $C_D = \overline{C}_D$ in (3.1) and solving for z_0.

ZOMOD1

This method computes the surface roughness length from (3.1) and (3.2), using Table 3.2. The weighting factors for three terrain classes are $f_1 = 0.85$, $f_2 = 0.125$, and $f_3 = 0.025$. If only two classes are specified, $f_1 = 0.85$ and $f_2 = 0.15$; if there is only one terrain class, $f_1 = 1.0$.

ZOMOD2

This method uses an on-site value of surface roughness length supplied by the user, or if that is not available, a default value (set at 0.3 m) is used. By using (3.1) and (3.2), the user can define a z_0 for various wind direction sectors that correspond to major variations in terrain and land use. Then, the appropriate z_0 value in the user-supplied on-site data pathway that corresponds to the wind direction is specified.

SURFACE FRICTION VELOCITY, SURFACE SENSIBLE HEAT FLUX, AND THE MONIN-OBUKHOV LENGTH

The Monin-Obukhov stability length (L) is expressed as a function of surface sensible heat flux (H_0) and momentum flux (u_*):

$$L = -u_*^3/[k(\frac{g}{T_0})(\frac{H_0}{\rho c_p})], \tag{3.3}$$

where g is the gravitational acceleration, k is the von Karman constant, T_0 is the shelter temperature near the surface, ρ is the density of dry air, and c_p is the specific heat at constant pressure.

HMOD1 and USMOD1

Direct measurements of u_* and H_0 require turbulence measurements of heat and momentum and may not be available on an everyday basis. Businger *et. al*. (1971) related L to a more easily computed stability parameter, the gradient Richardson number (Ri):

$$\overline{z}/L = (\phi_m{}^2/\phi_h)\ Ri, \tag{3.4}$$

where $\overline{z}$ is the geometric mean height between observation levels and ϕ_m and ϕ_h are the functional forms of the nondimensional gradients of wind and temperature. However, Ri requires measurements of wind speed and temperature at two levels. Barker and Baxter (1975) eliminated the need for a wind measurement at the lower level by relating L to a bulk Richardson number:

$$z_2/L = k\ Ri_B\ F^2/G, \tag{3.5}$$

where $Ri_B = z_2(g/T_0)\ \Delta\theta/u_2^2$. F and G are the integral forms of the flux profile relationships for momentum and heat (e.g., Dyer, 1974); z_2 is the upper observation height, $\Delta\theta = \theta_2 - \theta_1$, T_0 is the temperature at z_2, θ_1 is the potential temperature at the lower observation level, and u_2 is the wind speed at z_2.

The functions of F and G are those given by Paulson (1970) and modified by Nickerson and Smiley (1975) to express Ri_B as a monotonic function of z/L. Benoit (1977) further modified F and G so they are well-behaved numerically for small values of $|z/L|$. Irwin and Binkowski (1981) adapted Benoit's formulation, which we use here.

A relaxation technique is used to compute L from (3.3), beginning with an initial guess for L. When L converges, u_* is computed as follows:

$$u_* = u_2/F, \qquad (3.6a)$$

and H_0 is computed in the following manner:

$$H_0 = (\rho c_p)(\Delta\theta)(u_*)/G. \qquad (3.6b)$$

Care must be taken in specifying $\Delta\theta$, because small errors in $\Delta\theta$ may cause significant errors in the surface heat flux. The measurements of θ and u_* should be carried out at a mast. The height of the upper measurement level should be equal to $100z_0$, but not less than 10 m. The lower measurement level should be at $20z_0$, but not less than 1 m. For $z < 20z_0$, Monin-Obukhov similarity theory is not applicable.

HMOD3 and USMOD3

When low-level profile data are not available, u_* and H_0, and therefore L, can be computed from available standard weather observations (Holtslag and van Ulden, 1983). During unstable conditions in the daytime, the energy balance for heat flux density can be parameterized to yield a value for H_0, and at nighttime, H_0 is proportional to u_* and the surface scaling temperature (θ_*).

The energy balance for heat flux at the earth's surface can be expressed as follows:

$$H_0 + \lambda E = Q^* - G, \tag{3.7}$$

where λE is the latent heat flux density, Q^* is the net radiation, and G is the soil heat flux density. Priestley and Taylor (1972) expressed λE as a function of $(Q^* - G)$ by the following equation:

$$\lambda E = \alpha \frac{s}{s + \delta} (Q^* - G), \tag{3.8}$$

where s is the slope of the saturation vapor pressure/temperature curve, δ is the psychrometric constant, and α is an empirical constant. In the absence of advection, they found $\alpha = 1.26$ in summer, when averaged over saturated land surfaces and water. Combining (3.5) and (3.7) and solving for H_0 yields the following:

$$H_0 = \left\{ \frac{(1 - \alpha) + \delta/s}{1 + \delta/s} \right\} (Q^* - G). \tag{3.9a}$$

In experiments over a large shallow lake, De Bruin and Keijman (1979) developed a modified Priestley-Taylor formula:

$$H_0 = \left\{ \frac{(1 - \alpha') + \delta/s}{1 + \delta/s} \right\} (Q^* - G) - \beta', \tag{3.9b}$$

where α' and β' are empirical coefficients. The non-zero intercept is due to a seasonal variation of α in (3.8). Priestley (1959) showed that when saturated air passes over a wet surface, $\alpha' \to 1$ and $\beta' \to 0$. For other conditions, α' and β' must be adjusted. When using meteorological tower data at Cabauw, the Netherlands, De Bruin and Holtslag (1982) found $\alpha' \approx 1$ under normal soil water conditions and $\alpha' \approx 0.65$ under dry conditions. The coefficient β' was found to vary between 0 and 20 W/m^2. Table 3.3 gives typical values of α' and β' for several situations.

TABLE 3.3. TYPICAL VALUES OF α' and β' AND CONDITIONS UNDER WHICH THEY OCCUR*

Description	α'	β' (W/m^2)	Example
Advection of saturated air above wet surface	1	0	A wet surface is a water surface or a land surface covered with a thin water layer.
Advection of unsaturated air above wet surface	1.3	0	A saturated surface is a water surface or a moist cropped land surface.
Advection of unsaturated air above a relatively moist surface	1 or 1.15	20 or 0	Typical Dutch surface conditions, green growing grass, no lack of water.
Relatively dry surface conditions	0.45	9	Obtained from the Prairie Grass data.
Bare soil, no vegetation, no water available	0	0	Typical values for cities, railways, highways and bare soil (no evaporation).

* Source: DeBruin and Holtslag (1982), Holtslag and van Ulden (1983).

Typically, G is chosen to be 0.1Q* and δ/s can be approximated as exp[6.42 - T(°C)/17.78] for T between -5°C and 35°C (Irwin et al., 1985). Q* is parameterized in terms of time of day [solar elevation angle (ϕ)], near-surface temperature (T), fractional cloud cover (N) and albedo (r) through the following equation (calculation of the solar elevation angle is described in Appendix A):

$$Q^* = \frac{\overset{\text{I}}{(1 - r)(a_1 \sin\phi + a_2)(1 + b_1 N^{b_2})} + \overset{\text{II}}{c_1 T^6} + \overset{\text{III}}{c_2 N} - \overset{\text{IV}}{\sigma T^4}}{\underset{\text{V}}{1 + c_3}}. \qquad (3.10)$$

The coefficients a_1, a_2, b_1, b_2, c_1, c_2, and c_3 are empirical coefficients that may be site-specific. Table 3.4 presents the values used here and the locations at which they are valid or were evaluated. The albedo was chosen to be 0.23, representative of short grassy areas under normal soil water conditions. In term IV, σ is the Stefan-Boltzman constant.

TABLE 3.4. COEFFICIENTS FOR THE INCOMING SOLAR RADIATION AND LOCATIONS AT WHICH VALUES WERE OBTAINED OR ARE VALID*

Coefficient	Value	Units	Location
a_1	990	W/m^2	Yorkshire
a_2	-30	W/m^2	Yorkshire
b_1	-0.75	—	Hamburg, Germany
b_2	3.4	—	Hamburg, Germany
c_1	5.31×10^{-13}	$W/(m^2)(K^6)$	General agreement throughout northern hemisphere
c_2	60	W/m^2	Mid-latitudes
c_3	0.12	—	Cabauw, the Netherlands

* Source: Holtslag and van Ulden (1983).

In the first term (I) on the right-hand side of (3.10), the first factor represents the solar energy absorbed by the earth's surface, the second factor is the amount of radiation reaching the earth's surface with clear skies, and the third factor is a correction for cloud cover. The second term (II) represents the incoming longwave radiation for clear skies, and III is the correction for clouds. Term IV represents the outgoing longwave radiation, and c_3 in V represents a heating coefficient for the surface. We use $c_3 = 0.12$, but Holtslag and van Ulden (1983) suggested that c_3 is a function of atmospheric and soil conditions, and temperature. In combination with these coefficients in (3.10), the sensible heat flux for unstable conditions is obtained from (3.9b), with $\alpha' = 0.65$ and $\beta' = 20$ W/m^2.

The surface friction velocity is obtained in a similar manner, except that the relaxation scheme for L discussed earlier is used. With a known value for H_0, $u_\star = U/F$ (U is the surface observation wind speed); L is computed from (3.3). When L converges, the desired $u_\star$ has been determined.

For nighttime cases[†], H_0 is related to u_* and the surface scaling temperature (θ_*) through the following equation:

$$H_0 = -\rho \, c_p \, u_* \, \theta_*. \tag{3.11}$$

As in the daytime case, u_* and θ_* could be determined from the profiles of wind and temperature. Venkatram (1980) suggested that $\theta_* \sim 0.1$ K for clear skies. Holtslag and van Ulden (1982) provided a method for computing θ_* and u_* from regular nighttime surface observations.

For the sun below the horizon and stable conditions, satisfactory results are obtained from the following equation:

$$\theta_* = 0.09(1 - 0.5N^2). \tag{3.12}$$

For $N = 0$, $\theta_* = 0.09$ K, which agrees with the 0.1 K value suggested by Venkatram. If the sun is above the horizon, but the heat flux is downward, then the equation below is used:

$$\theta_* = 0.09(1 - 0.5N^2)[1 - (\phi/\phi_0)^2], \; 0 < \phi < \phi_0. \tag{3.13}$$

The variable, ϕ_0, is the critical solar elevation angle at which the atmosphere becomes unstable (when H_0 changes sign) and is a function of cloud cover. Holtslag and van Ulden (1983) found that $\phi_0 = 13°$ for $N \leq 0.75$, and ϕ_0 increases to 23° for $N = 1.0$. The value of ϕ_0 can be explicitly determined; this procedure is used here and is outlined in Appendix B.

Holtslag (1984) has suggested that the Monin-Obukhov length for stable conditions is given by the following equation:

$$L = (L_n - L_0) + \{L_n(L_n - 2L_0)\}^{1/2}. \tag{3.14}$$

[†] Nighttime is taken to be the period when the true solar elevation angle (ϕ) (see Appendix A) is less than a critical solar elevation angle (ϕ_0).

L_n and L_0 are length scales given as follows:

$$L_n = \frac{kU^2T_0}{2g\theta_*\{\ln(z/z_0)\}^2}$$

and

$$L_0 = \frac{\alpha z}{\ln(z/z_0)},$$

where U is the wind speed at height z, θ_* is the scaling temperature, z_0 is the surface roughness length, and α is the coefficient in the linear term in the log-linear wind profile of the stable atmosphere.

For $L_n < 2L_0$, real solutions do not exist. Holtslag suggested that L be defined as follows:

$$L = (L_0 \ L_n/2)^{1/2}, \tag{3.15}$$

which is continuous for $L = L_0$.

MIXING HEIGHT

The mixing height (h_m) defines the layer above the surface in which pollutants are mixed by the presence of turbulence. During the daytime, solar heating of the earth's surface causes the layer to deepen, typically to 1-2 km. This layer is usually capped by an inversion at which significant vertical mixing is inhibited. In strong convective conditions, the mixing height and the base of the elevated inversion (z_i) are nearly the same. Convectively generated turbulence is expected to dominate the mechanically generated turbulence during these periods.

For stable conditions, buoyancy forces suppress the turbulence, inhibiting mixing and making h_m difficult to define. A surface-based inversion usually exists and may extend upwards to several hundred meters. The mixing height and the height of the top of the surface-based inversion

(h_i) may differ quite markedly in stable conditions, and there is no simple relationship between these two heights. Advection of cool air over a warmer surface could lead to a convective mixing height. No provisions are provided in this version of the processor to model these effects.

The metprocessor contains several methods for estimating the convective and mechanical mixing layer heights (z_i and z_m, respectively). It is assumed that the largest of the estimates correctly reflects the dominant turbulence generation mechanism (Garrett, 1981) for very stable and unstable conditions. However, in the early evening (the hours just after sunset) when the stable inversion depth is just beginning to be established by cooling from the underlying surface, none of the diagnostic methods considered here for characterizing the mixing depth or the turbulence are adequate. As a first-order approximation, we have elected to define h_m as z_m. This is recognized as inappropriate, and we await future research for the development of better methods. The inversion height is discussed in more detail in the section on temperature profiles.

ZCMOD2 and ZMMOD1

Benkley and Schulman (1979) proposed a model for estimating both a convective and a mechanical mixing height (z_c and z_m) from regularly observed surface and upper air data. The convective mixing height for the time period was defined as the intersection of the dry adiabat, defined by the surface (shelter) temperature for the time period, with the morning sounding. We modify this by using the interpolated hourly sounding that corresponds to the hour of sunrise.†

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† It is assumed that the interpolated upper air data are available hourly.

Benkley and Schulman adjusted the estimates for convective mixing height by incorporating the effects of large-scale advection on the observed surface temperature as follows:

$$T = T_t - \frac{t}{12} [T_{700} \text{ (sunrise + 12h)} - T_{700} \text{ (sunrise)}], \qquad (3.16)$$

where T is the adjusted temperature, T_t is the observed surface temperature t hours after sunrise, and T_{700} is the temperature at 700 mb for the times indicated. All temperatures are expressed in degrees Celsius. However, if the temperature difference becomes greater than 10°C, the advection is assumed to be zero. A second modification corrects for observed temperature differences between the first level of the radiosonde and surface observation data at sunrise. This is discussed in the section on temperature profiles.

Whenever the mixing ratio (r) exceeds the saturation mixing ratio (r_s), or the virtual potential temperature (θ_v) at the surface is less than θ_v at the mixing height, the mixed layer does not grow. The convective mixed layer depth estimated by this method can only deepen or remain the same depth throughout the day; it can never become more shallow. If the dry adiabat does not intersect the sunrise sounding, the top of the mixed layer is considered to be the highest level in the radiosonde profile.

Benkley and Schulman (1979) also proposed a nighttime mechanically driven mixed layer depth (z_m) estimated from the equation below:

$$z_m = C_m u_*/f, \qquad (3.17)$$

where $C_m = 0.133$. Because the winds try to approach equilibrium but never attain it, a 3-h average of u_*, centered on the hour, is used.

ZCMOD1

Garrett (1981) suggested a model for estimating the depth of the convective mixed layer (z_c) based on the prognostic equations derived by Tennekes (1973). This is coupled with Deardorff's (1974) free convection formula whenever the strength of the temperature difference across the inversion falls below an arbitrary minimum value. The Tennekes equations require knowledge of the surface heat flux. The equations can be solved for the time rate of change of θ_v, which can be determined from radiosonde data.

For a horizontally homogeneous atmosphere, in which horizontal advection and large-scale subsidence are not considered, the mixed layer depth is as follows:

$$z_c^{k+1} = z_c^{k} \exp\left\{\frac{C(\theta_v^{k+1} - \theta_v^{k})}{(1 + C)\,\Delta}\right\}. \qquad (3.18)$$

The superscript, k, represents the time step; C is an entrainment coefficient; and Δ is the "jump" in temperature across the inversion at the top of the mixed layer. Here we compute Δ as the difference between θ_v at z_c and the dry adiabat, defined by θ_v at the surface.

In cases where $\Delta \to 0$, z_c will tend to infinity. For those situations, the free convection estimate based on the work of Deardorff (1974) is used, and z_c is given as follows:

$$z_c^{k+1} = \left\{(z_c^{k})^{1/3} + 0.067(t^{k+1} - t^{k}) \left[\frac{(d\theta_v/dt)^{k}}{(1 + C)\,\overline{\theta}_v}\, g\right]^{1/3}\right\}^{3}, \qquad (3.19)$$

where $t^{k+1} - t^{k}$ is the time step in hours, g is the gravitational acceleration, $\overline{\theta}_v$ is a mean virtual potential temperature for the mixed layer, and C is a seasonally varying entrainment coefficient. In winter, when the solar elevation angle is low (in the northern hemisphere), surface heating is small, and entrainment is expected to be small. In summer, the solar elevation angle is high, and entrainment is expected to be larger. Garrett (1981) suggested a coefficient of the following form:

$$C = 0.15(1 - |M - 6|/6) + 0.05, \tag{3.20}$$

where M is the month of the year (1-12).

The mixed layer depth is estimated over 5-min increments within each hour. To improve the estimates of the mixing height, the two modifications suggested by Benkley and Schulman (1979) are incorporated. The maximum rate of growth is limited to 0.4 m/s. The height determined at the last time step in the hour is defined as the mixing height for the hour. As with the Benkley and Schulman model, the convective mixed layer can only deepen or remain the same depth over the course of the day. No growth is assumed whenever the surface virtual potential temperature is less than the virtual potential temperature at h_m, or whenever $r \geq r_s$ at the top of the mixed layer and $\Delta > 0$. If $\Delta \leq 0.0$, or $r < r_s$, the mixed layer can deepen.

ZMMOD2

An alternative to Benkley and Schulman's mechanical mixing height model is given by Nieuwstadt (1981). From the solution of the equations of motion for a steady, homogeneous atmospheric boundary layer with constant eddy viscosity (K),

$$z_m = c'(K/f)^{1/2}, \tag{3.21}$$

where f is the Coriolis parameter, and c' is a constant of proportionality. Employing the results of Brost and Wyngaard (1978) and Zilitinkevich (1972) in (3.21), Nieuwstadt derived an expression for the height of the stable mixed layer:

$$z_m = (0.3u_*/f)/(1.0 + 1.9z_m/L). \tag{3.22}$$

The solution to (3.22) is as follows:

$$z_m = \frac{-1 + [1 + 4(1.9/L)(0.3u_*/f)]^{1/2}}{2(1.9/L)},$$

where u_* is, as before, a 3-h average centered on the hour. The height of the mechanically mixed layer is given by (3.22) for nighttime and by (3.17) for daytime.

HEIGHTS

The user has a choice between two methods for calculating heights. In HTMOD1, the user explicitly specifies the heights. These unmodified heights are entered into the height array; the heights are repeated for each hour of the 24-h period.

In HTMOD2, the user specifies the fractions of the mixing height that are to define the heights. The subroutine then computes the actual heights and enters them into the height array. Because mixing height varies hourly, the heights will vary from hour to hour. If the mixing height is missing, then all profile heights are missing.

Both subroutines specify a maximum of 20 heights. The parameter called HTLEV in the METOUT PROC must be changed if the user requires additional heights (see Section 7 for more on PROCs).

TEMPERATURE PROFILES

During the daytime, when convective processes dominate, the potential temperature (θ) is typically observed to be constant in the convectively mixed layer. Associated with strong surface heating, a superadiabatic temperature lapse rate is observed in a shallow layer close to the surface. Convective mixed layers are generally capped by a temperature inversion.

At nighttime, with clear skies and strong radiative heat loss, a surface-based temperature inversion forms and deepens throughout the night (e.g., Andre and Mahrt, 1982). The distinction between the mixed layer height (h_m) and the surface-based inversion height (h_i) becomes more apparent, although there is no simple relationship between the two heights. Excluding the transition period after sunset, the surface-based inversion confines the turbulence to a shallow layer near the ground, $h_m < h_i$.

TMOD1

Temperature profiles are constructed in the following way. Potential temperature in the convective mixed layer ($z < h_m$) is assumed to be constant with height and the same as the potential temperature at the first level of the hourly radiosonde report. Above h_m, the interpolated values of the radiosonde data are used. The inversion height is set equal to the mixing height during convective conditions. All the hourly profiles of potential temperature from upper air data, day or night, are adjusted so the surface value from the upper air data is in accord with the hourly surface weather observation data. A correction factor ($\theta_c = \theta_s - \theta_u$, where θ_s is the surface observation temperature, and θ_u is the lowest level of the hourly upper air θ) is added to each upper air value of θ. This has the effect of shifting the entire profile by an amount θ_c.

The construction of the nighttime temperature profile requires an estimate of the height of the top of the surface-based inversion. From experiments in the Po Valley in northern Italy, Anfossi et al. (1976) found the following to be true:

$$h_i = A_i t^b, \tag{3.23}$$

where $A_i = 70$, $b = 0.5$, t is the time in hours after the maximum surface temperature was observed, and h_i is given in meters. The maximum temperature is constrained to occur between 1200 LST and 1800 LST.

For profile heights below the shelter height, the surface weather observation temperature is used; for heights above h_i, interpolated radiosonde values are used. Yamada (1979) suggested a simple empirical expression for heights between the shelter height and h_i:

$$\frac{\theta - \theta_h}{\theta_h - \theta_s} = -\left(\frac{h_i - z}{h_i - z_s}\right)^3 \qquad (3.24)$$

The subscripts, h and s, refer to the inversion height and shelter height (taken to be 1.2 m), respectively; $z' = z - z_s$, $h' = h_i - z_s$, where z is the profile height. We chose the value for c to be 3; Yamada warns that this coefficient may be site-specific.

The atmosphere is seldom in a dynamically neutral state. However, in the absence of strong surface heating or cooling or with strong surface winds, day or night, the daytime and nighttime models are inappropriate. McBean (1979) reported that values of $-h_m/L \sim 1$ are sufficient to drive the boundary layer into convective conditions. For $|h_m/L| \leq 1.0$, the interpolated values of the radiosonde temperatures are used for all heights in the profile. The inversion height is set equal to the mixing height.

WIND PROFILES

Whenever convective processes dominate, the wind speed and direction are nearly independent of height within the mixed layer and free convection layer. Most of the wind speed shear is confined to a shallow layer near the surface where surface stresses are most important. Near the top of the convective layer, wind speed and direction adjust rapidly to conditions above the mixing height.

During the nighttime, with strong radiational cooling, wind speed increases with height throughout the depth of the surface-based inversion layer. At some height, the winds may become supergeostrophic, associated with the formation of a low-level nocturnal jet (Thorpe and Guymer, 1977). The jet maximum is typically near the top of the inversion layer (Mahrt _et al_., 1979). Wind direction is nearly constant in the surface layer, but turns rapidly with height between the surface layer and inversion height. The surface layer is defined by $z_0 \ll z < \min(0.1h_m; -L)$.

The typical profile of the wind, both day and night, can be modified by terrain effects (slope flows at night and upslope flows resulting from differential heating during the day), baroclinic effects, and isallobaric wind effects.

UVMOD2

Monin-Obukhov similarity (Yaglom, 1977) is used to describe the winds in the surface layer. From a single observation of speed and direction and estimates of the parameters z_0 and L, the wind velocity can be estimated. Above the mixing height, the winds are derived from upper air reports. At intermediate heights, the winds are assumed to be somewhere between these values, with the winds matched at the top of the surface layer. Upper air data, interpolated in time, are integrated with the similarity theory by using procedures outlined by van Dop _et al_. (1981).

In the surface layer, the wind speed (U_{SL}) at a specified height (z) is given as follows:

$$U_{SL} = U_r \, (F_z/F_r), \tag{3.25}$$

where U_r is the wind speed at a reference height z_r (taken to be 10.0 m), F_z is the similarity function for momentum computed at z, and F_r is the similarity function at z_r. The wind direction is assumed to be constant and in the direction of the wind at height z_r. Paulson (1970) derived the integrated form of the nondimensional gradient of wind shear for an unstable atmosphere; it was later modified by Nickerson and Smiley (1975) and Benoit (1977).

For stable conditions, the familiar log-linear expression is used to estimate F_z. When $z/L \geq 0.5$, F_z is better estimated by a semi-empirical extension of the log-linear expression (Holtslag, 1984):

$$F_z = \ln (z/z_0) + 7.0 \ln (z/L) + 4.25/(z/L) - 0.5/(z/L)^2 + 0.852. \quad (3.26)$$

F_r is given by the following log-linear expression:

$$F_r = \ln (z/z_0) + \beta\ z/L, \quad (3.27)$$

with $\beta = 5.0$. Equations (3.26) and (3.27) yield the same value when $z/L = 0.5$.

For the layer above the surface layer but below h_m, the winds can be determined from a weighted average of winds computed by similarity theory (U_{SL}) and the upper air data (U_G):

$$U = f_s\ U_{SL} + (1 - f_s)U_G, \quad (3.28)$$

where f_s is the fractional contribution from similarity theory. Values for wind speeds from the upper air data (U_G) are interpolated to the specified profile height. The functional form of f_s, as shown in Figure 3.1, was chosen so that it is a continuous and monotonically decreasing function from 1 (at $z/h_m = 0$) to 0 (at $z/h_m = 1.0$) (van Dop et al., 1981). Above h_m, interpolated values of the upper air data are used to complete the profile.

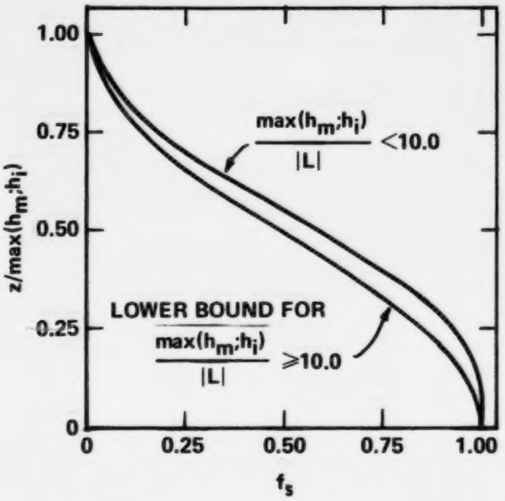

Figure 3.1. Weighting function, f_S, for wind speed and wind direction as a function of scaled height and stability.

UVMOD3

The use of upper air data interpolated in time may produce unrealistic profiles if one of the twice-daily ascents does not portray important features in the wind and temperature profiles in the lower atmosphere. For example, surface-based inversions or wind velocity maxima in the lower 400 m of the atmosphere may be poorly described or not even recorded. Hourly observations of multilevel on-site data can be incorporated to supplement the information in the lowest part of the atmosphere and improve the profile results. Such data may be from an instrumented meteorological tower or a remote sensor, such as sodar or lidar.

For profile heights below the lowest level of on-site data, similarity theory and (3.25) are used, with the reference level being the lowest level of on-site data. Between the lowest and highest on-site levels, interpolated values of on-site winds are used. Above the highest level, but below the mixing height or inversion height (whichever is greater), similarity theory and upper air data are combined according to (3.28) by using the function f_s shown in Figure 3.1., with the reference level now being defined as the highest on-site level. Above the mixing height, interpolated upper air data are used to complete the profile.

UVMOD4

In an initial evaluation of the wind profiles generated by using NWS data and the UVMOD2 procedure, Irwin (in press) noted that the wind direction shear was overestimated at night and the increase of wind speed with height was slightly overestimated during the day and underestimated at night. In UVMOD2, the wind profile is constructed as a weighted average of estimates of the wind profile based on surface-layer theory (U_{SL}) and the wind profile derived from upper-air reports (U_G), as given by (3.28).

To correct for the deficiencies described for UVMOD2, a new weighting function, f_s, was used in UVMOD4. The weighting function for wind speed is treated separately from the weighting function for wind direction. Three stability regimes are used to define the weighting function: stable ($h_m/L > 1$), neutral ($|h_m/L| \leq 1$), and unstable ($h_m/L < 1$).

Figure 3.2 depicts f_s for wind direction (a) and wind speed (b). Preliminary comparisons suggest a value of 0.7 for the constant, A, in the figure. During stable and neutral conditions, the averaging of the surface-layer wind profile and the upper-air wind profile extends to $1.2h_{max}$, where h_{max} is the maximum mixing height during the 24-h period from midnight to midnight. This approximates the observed tendency for the winds to adjust throughout the night within the region above the surface inversion, which is well-mixed during the preceding day by convective processes.

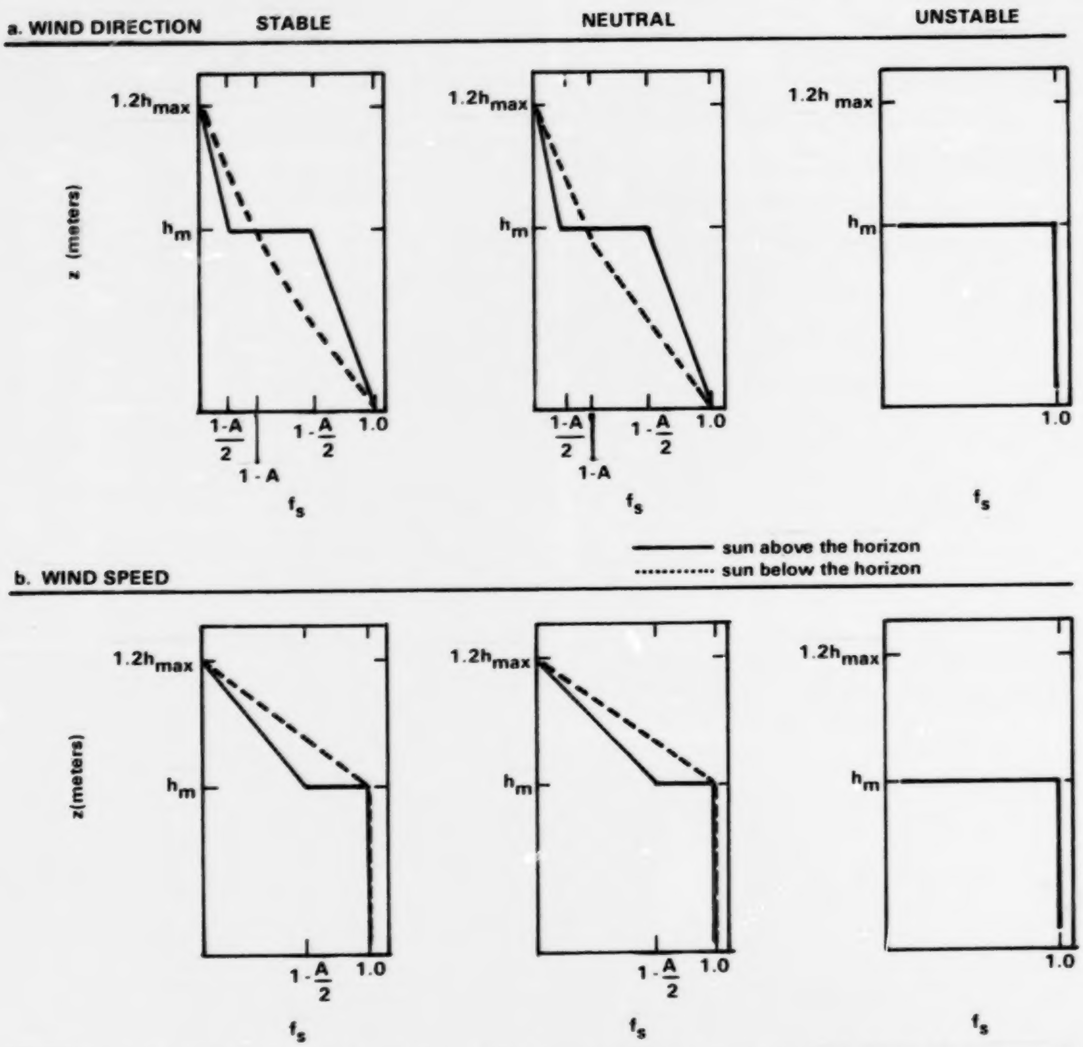

Figure 3.2. Weighting function, fs, for wind direction (a) and wind speed (b) as a function of height and stability. Mixing height is h_m, and h_{max} is the maximum mixing height during the 24-h period from midnight to midnight. A value of 0.7 was chosen for the constant A.

TURBULENCE PROFILES

Numerical and observational studies indicate that the vertical velocity variance (σ_w^2) in the convective mixed layer exhibits a maximum between $0.3h_m$ and $0.6h_m$ (e.g., Wyngaard et al., 1974; Deardorff, 1974; Kaimal et al., 1976; LeMone and Pennell, 1980), and the height and magnitude of the maximum increase with increasing convective instability (Nicholls and Reading, 1979). Above the mixing height, the fluctuations decrease by an order of magnitude and are probably associated with entrainment and internal waves (Caughey and Palmer, 1979). Horizontal velocity variances (σ_v^2) exhibit a slight maximum near $0.8h_m$ (Caughey and Palmer, 1979) and are of the same magnitude as the vertical fluctuations.

At nighttime, when the lower atmosphere is stably stratified, both the horizontal and vertical fluctuations decrease rapidly in amplitude as a function of height (Caughey, 1982), becoming nearly zero at h_m.

SWMOD1 and SVMOD1

Højstrup (1981, 1982) and Berkowicz and Prahm (1982) modeled the velocity spectra in terms of a buoyancy-produced and shear-produced contribution. By combining the shear-produced contribution (Højstrup, 1982) and buoyancy-produced contribution (Baerentsen and Berkowicz, 1984), the vertical and lateral turbulent variances below h_m can be characterized as follows:

$$\sigma_w^2 = (1.54\, u_*^2\, k^{-2/3})(-z/L)^{2/3} \exp(-2z/h_m) + 1.457\, u_*^2\, (1 - z/h_m)^2, \qquad L < 0 \qquad (3.29a)$$

$$= 1.457\, u_*^2\, (1 - z/h_m)^2, \qquad L > 0 \qquad (3.29b)$$

$$\sigma_v^2 = 0.7\, u_*^2\, (-h_m/L)^{2/3} + 2.7\, u_*^2\, (1 - z/h_m)^2/(1 + 2.8z/h_m)^{2/3}, \qquad L < 0 \qquad (3.29c)$$

$$= 2.7\, u_*^2\, (1 - z/h_m)^2/(1 + 2.8\, z/h_m)^{2/3}, \qquad L > 0 \qquad (3.29d)$$

For profile heights above h_m, the variances can be characterized as follows:

$$\sigma_w^2 = (1.54\, u_*^2\, k^{-2/3})(-z/L)^{2/3} \exp(-2z/h_m), \qquad L < 0 \qquad (3.30a)$$

$$= 0, \qquad L > 0 \qquad (3.30b)$$

$$\sigma_v^2 = 0.7\, u_*^2\, (-h_m/L)^{2/3}, \qquad L < 0 \qquad (3.30c)$$

$$= 0, \qquad L > 0 \qquad (3.30d)$$

SWMOD2 and SVMOD2

If on-site values of the variances can be obtained, the derived profiles can be adjusted to reflect this information. A correction factor for the vertical variances, measured value/value obtained from (3.29), multiplies each value of the variances computed from (3.29). A similar correction factor for the horizontal variance can also be applied.

SECTION 4

TECHNICAL GUIDANCE FOR INPUT DATA

INTRODUCTION

This section describes the input data and file formats required to process data through the series of programs that comprise the MPDA-1 system. It is assumed here that the user has successfully loaded, compiled, and mapped (or linked) the programs. Consult Section 7 for a discussion on the configuration of files on the NTIS tape and on the nonstandard FORTRAN (NAMELIST and INCLUDE) used in the system. Section 5 presents a sample problem that illustrates the MPDA-1 system.

The metprocessor is the heart of the system. However, before the metprocessor can be used, the input data must be organized. The preprocessor moves data along three independent pathways, which correspond to the three types of data used by the system. The three data types consist of National Weather Service (NWS) radiosonde data, NWS hourly surface observation data, and user-supplied on-site data. MERGE, the final program in the preprocessor, combines the data from each pathway into one file, which is used by the metprocessor.

Because the preprocessor consists of a sequence of programs, the output file format of one program in the sequence is the input file format for the next program in the sequence. If programs are optional, the input and output file formats of the program are identical. Therefore, once the user has formatted his data file, he does not have to format the rest of the files in the sequence, because their formats are identical. Consequently, this section only provides the information necessary to execute the programs from the beginning of the sequence. File format requirements for programs at other points in the sequence are listed in tabular form in Appendix C. The on-site data pathway is an exception, because of the variability of formats for this data type.

CAUTION: There are several variables used in MERGE and the metprocessor that are defined by minimum or maximum array bounds. The maximum number of levels in a radiosonde report (IRSLEV) is set at 40. For on-site data, the maximum number of levels (ISTLEV) is set at 15. The maximum number of user-supplied profile heights (HTLEV) is 20. The hourly variables begin with hour 0 (MINHR) and end with hour 23 (MAXHR). These values can be easily modified by changing the values defined in the PROCs (see Section 7).

All of the programs except the QA routines require some user-supplied data in the form of input card images. The data are read through the system's input logical file (unit 5 on the UNIVAC and defined in the PROCs) with a list-directed (free format) READ.

CAUTION: It is important that each value in a list-directed READ be separated by a comma or blank, and that each variable has a value associated with it that conforms to the type declaration in the program.

ATAPE

The SCAN and EXTRACT programs use a magnetic tape handler called ATAPE to read the upper air and surface observation data tapes from the National Climatic Data Center (NCDC). Consecutive observations are grouped into blocks on the data tape to form a physical record. ATAPE reads one physical record from the tape*, beginning with the first record, and transfers it to an array. The remainder of a program decodes the array and retrieves the logical records from the physical records. ATAPE is not limited to reading a particular blocking structure, because it reads in one physical record. ATAPE is capable of reading fixed-length and variable length blocks. For example, one structure NCDC uses to block surface observations is 80 characters (1 observation period)/logical record and 10 logical records/block, or 800 characters per block. The upper air data are blocked at 25 characters/logical record and can have a variable number of logical records/block, up to 6000 characters/block. ATAPE is capable of reading both structures.

ATAPE was written by the personnel at the Atmospheric Sciences Research Laboratory of the Environmental Protection Agency for use on the Sperry UNIVAC at the National Computer Center. It is an assembly language routine. The version on the UNIVAC is a multifunctional routine capable of reading from and writing to magnetic tapes, rewinding tapes, writing EOF's to tape files, and moving tapes forward and backward. The routine included with this version of MPDA-1 consists only of a discussion of the arguments and functions of ATAPE. The comments in the code include the assembly language code, in case the user implements the MPDA-1 system on a UNIVAC 1100 series machine.

There are no current standard ASCII FORTRAN equivalents for the information provided by ATAPE when it is used to read a tape. The user will have to develop his own routine to read the magnetic tapes, or use a system routine (for example, NTRAN$ on the UNIVAC, BUFFERIN on a CYBER) from his computer facility, if one is available.

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* NCDC data tapes generally consist of only one file, with all the data requested contained in the single file.

In addition to ATAPE, there are other statements in the programs that are machine-dependent. This dependency relates to the type of computer: either word-oriented or byte-oriented. The UNIVAC is a word-oriented computer in which addresses reference words. Other word computers include the CRAY and CDC mainframes. There are also byte-oriented computers, such as IBM and DEC equipment, in which addresses reference bytes.

The code for the MPDA-1 is currently set up for computations on a word-oriented computer. To change this, change the parameter called MFACT from 1 (for word-oriented computers) to 4 (for byte-oriented computers) in the PARAMETER statement defining this value. This parameter appears in the SCAN and EXTRACT programs for radiosonde and surface observation data.

PREPROCESSOR

Radiosonde Data Pathway

TAPE FORMAT

Radiosonde data for North America is archived at the NCDC in Asheville, North Carolina. Two formats are available from NCDC: fixed-length physical records in either ASCII or EBCDIC character format, and variable-length physical records available only in EBCDIC character format. The MPDA-1 was developed to accomodate the latter format, although the former one, with EBCDIC character format would work equally well. When a request for data on magnetic tape is made, NCDC includes the tape format document TD-56 VAR, Upper Air Rawinsonde Observations, with the tapes requested. This document describes the data format in detail. We understand that the NCDC is in the process of revising its tape formats. The user may wish to write or phone the NCDC directly for details. The address and phone number are as follows:

National Climatic Data Center
Federal Building
Asheville, NC 28801
(FTS) 672-0683
704/259-0683

THE PROGRAMS

As illustrated in Figure 4.1, the radiosonde data pathway consists of a series of six programs, several of which are optional. These programs are called SCAN-UPPR, EXTRACT-UPPR, CONVERT-UPPR, QA-UPPR, REDUCE, and HRLY-INTERP. The optional SCAN-UPPR program is provided for the convenience of the user, because the NCDC tapes frequently contain more than one station's data or more than one year's data. Thus, it is useful to have a scan program to summarize the information on a tape. If the user chooses to use the optional QA program, he may wish to run it several times to evaluate questionable data values. Because radiosonde measurements extend to heights above the levels of interest to most diffusion modelers, an optional REDUCE program is provided to eliminate unnecessary data.

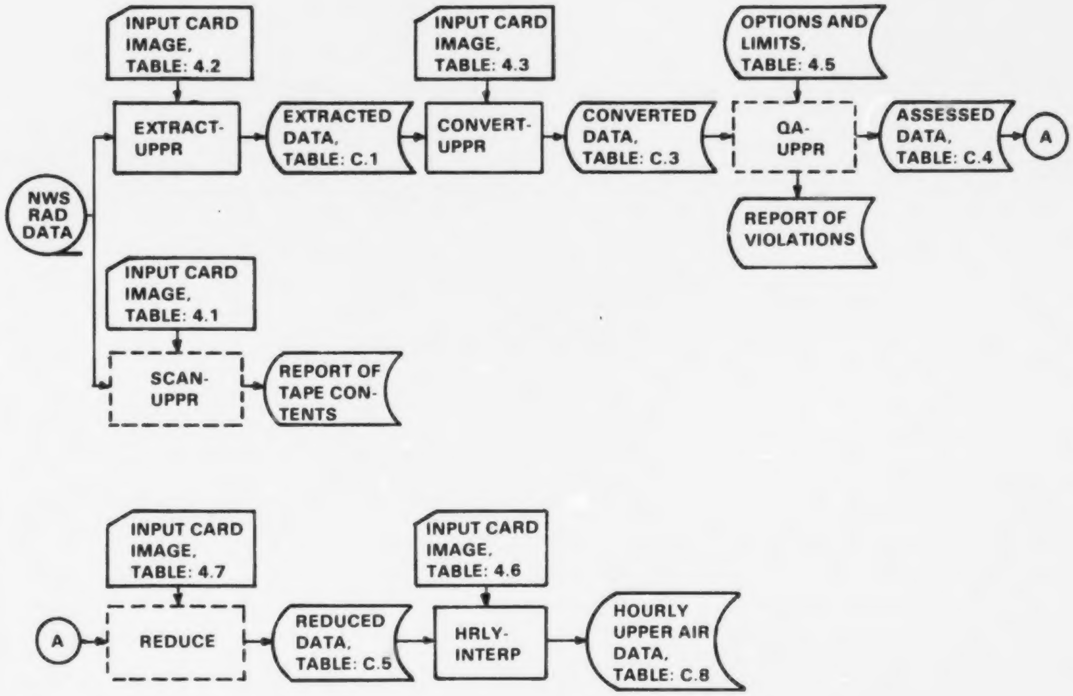

INPUT CARD IMAGE, TABLE: 4.2
INPUT CARD IMAGE, TABLE: 4.3
OPTIONS AND LIMITS, TABLE: 4.5
EXTRACT-UPPR
EXTRACTED DATA, TABLE: C.1
CONVERT-UPPR
CONVERTED DATA, TABLE: C.3
QA-UPPR
ASSESSED DATA, TABLE: C.4
A
NWS RAD DATA
REPORT OF VIOLATIONS
INPUT CARD IMAGE, TABLE: 4.1
SCAN-UPPR
REPORT OF TAPE CONTENTS
INPUT CARD IMAGE, TABLE: 4.7
INPUT CARD IMAGE, TABLE: 4.6
A
REDUCE
REDUCED DATA, TABLE: C.5
HRLY-INTERP
HOURLY UPPER AIR DATA, TABLE: C.8

Figure 4.1. The radiosonde data pathway in the preprocessor. Optional programs are indicated by dashed lines. Table numbers refer to tables in this section and Appendix C that specify format requirements.

INPUT CARD IMAGE AND FILE FORMAT REQUIREMENTS

SCAN-UPPR--As described earlier, this optional program surveys the original data set and reports the stations, days, and times recorded on the magnetic tape. Table 4.1 describes the user-supplied information required for the input card image of this program.

TABLE 4.1. INPUT CARD IMAGE FOR SCAN-UPPR*

Record Type	Number of Records	Variable	Description	Units	Format/Type†
1	1	CHFMT	Option to convert EBCDIC to ASCII character format. Specify "ASCII" to perform the conversion; for no conversion, specify any other character string	—	C*5

* Logical unit numbers are assigned as follows: input = 10; output = 7.

† C = character (maximum length as shown)

EXTRACT-UPPR--This program retrieves only those stations and days of interest to the user. Table 4.2 describes the user-supplied information required for the input card image of this program.

TABLE 4.2. INPUT CARD IMAGE FOR EXTRACT-UPPR*

Record Type	Number of Records	Variable**	Description	Units	Format/Type†
1	1	TAPENO	Magnetic tape identifier — used only in an output descriptive header	—	C*6
		JSTAT	Identifier of station to be extracted	—	I
		ISYR	Last two digits of the first year to be extracted	—	I
		IEYR	Last two digits of the final year to be extracted	—	I
		JULBEG	First Julian day, of each year, to be extracted	—	I
		JULEND	Final Julian day, of each year, to be extracted	—	I
		STLAT	Station latitude††	decimal degrees	R
		STLON	Station longitude††	decimal degrees	R
		CHFMT	Option to convert EBCDIC to ASCII character format. Specify "ASCII" to perform the conversion; for no conversion, specify any other character string.	—	C*5

* Logical unit numbers are assigned as follows: input = 7; output = 8.

** Variables must appear in the order shown.

† C = character (maximum length as shown); I = integer.

†† NWS station latitudes and longitudes may be found in National Weather Service, 1972.

CONVERT-UPPR--This program converts the extracted data to the meteorological units required by the metprocessor. Table 4.3 describes the user-supplied information required for the input card image of this program. In this case, only one variable must be supplied: the number of time zones away from Greenwich at which the station is located. For stations west of Greenwich, a positive value is entered; for stations east of Greenwich, a negative value is entered. Table 4.4 is a look-up table that provides this information for the western hemisphere.

TABLE 4.3. INPUT CARD IMAGE FOR CONVERT-UPPR*

Record Type	Number of Records	Variable	Description	Units	Format/Type†
1	1	HRSWST††	Number of time zones from Greenwich the station is located	—	I

* Logical unit numbers are assigned as follows: input = 8; output = 9.
† I = Integer.
†† See Table 9 to determine number of time zones.

TABLE 4.4. NUMBER OF TIME ZONES WEST OF GREENWICH, ENGLAND*

Time Zone	Standard Time	Daylight Time
Atlantic	4	3
Eastern	5	4
Central	6	5
Mountain	7	6
Pacific	8	7
Yukon	9	8
Alaska-Hawaii	10	9
Bering	11	10

* For selected western hemisphere standard and daylight hours.

QA-UPPR--Rather than a list-directed READ from an input card image, this program reads the limits and options as a NAMELIST-directed READ from a disk file created by the user and attached to logical file 9 (see Table 4.5). The NAMELIST group name appearing in the program that contains the variables to be given values is called TESTS. This nonstandard ASCII FORTRAN is explained in more detail for the UNIVAC in Section 7. If the NAMELIST-directed READ is available on your system, consult your system's reference manual on how to format the file.

The input file to be evaluated is attached to logical file 10, the output file is attached to logical file 12, and the report of violations is attached to logical file 11.

There are two input/output file formats available to the user. The first format, used by the EPA's Atmospheric Sciences Research Laboratory, consists of continuous data records; each record repeats the station identifier, date, and time within a radiosonde report (see Table C.2 in Appendix C). The second format conforms to the format found on the NCDC Asheville data tapes; it consists of a header with the station identifier, date, and time, followed by the levels of data (see Table C.3 in Appendix C). The preprocessor uses the second format, which corresponds to the input requirements of the MERGE program. A more detailed description of this QA program is given in Section 6.

TABLE 4.5. INPUT FILE OF LIMITS AND OPTIONS FOR QA-UPPR*

Record Type	Number of Records	Variable	Description	Units	Format/Type†
1	1	TSUPR	Lower limit for temperature change with height	°C/m	R
		TINVR	Upper limit for temperature change with height	°C/m	R
		WSHR	Upper limit for vertical shear of the wind vector	s^{-1}	R
		CALM	Control for checking for a non-zero direction if the wind speed is zero; if CALM is TRUE, check the direction; if CALM is FALSE, do not check the direction	—	L
		WSMX	Upper limit for wind speed	m/s	R
		DPD	Upper limit for dew point depression	°C	R
		TDPFIL	Control to estimate missing temperature and dew point via a linear interpolation with height: TRUE = make the estimates FALSE = do not make the estimates	—	L
		IFORM	Radiosonde data input format 1 = continuous data records (see input format option 1, Table C.2) 2 = partitioned data, used in MPDA-1 (see input format option 2, Table C.3)	—	I

---

* The checks on the lapse rates, wind shear and speed maximum, and dew point depression can be suppressed by specifying values large (or small) enough to ensure that the checks would never be violated. We recommend the following values for this purpose: TSUPR = -9999.0; TINVR = 9999.0; WSHR = 9999.0; WSMX = 9999.0; DPD = 9999.0.

† R = real; L = logical.

REDUCE--As described earlier, this optional program cuts off the number of levels of data in the radiosonde report at a user-specified height. Table 4.6 describes the user-supplied information required for the input card image of this program.

TABLE 4.6. INPUT CARD IMAGE FOR REDUCE*

Record Type	Number of Records	Variable	Description	Units	Format/Type†
1	1	CUTHGT**	Maximum height to which the radiosonde reports are to extend	m	R
		OFFSET	Option to adjust all levels in the radiosonde report so that heights are reported as above ground level: TRUE = adjust the heights FALSE = do not adjust the heights	—	L

* Logical unit numbers are assigned as follows: input = 10; output = 11.

** If the user chooses to adjust the heights, the heights are recomputed before deleting the records above CUTHGT.

† R = real; L = logical.

HRLY-INTERP--Because radiosonde data are often not in hourly intervals, this program, which interpolates the data to hourly values, is provided. Table 4.7 describes the user-supplied information required for the input card image of this program.

TABLE 4.7. INPUT CARD IMAGE FOR HRLY-INTERP*

Record Type	Number of Records	Variable	Description	Units	Format/Type†
1	1	IY1, IM1, ID1	Year (last two digits only), month, day to begin the interpolation	—	I
		IY2, IM2, ID2	Year (last two digits only), month, day to end the interpolation	—	I

* Logical unit numbers are assigned as follows: input = 9; output = 10.

** IY1 and IY2 are the last two digits of the year.

† I = integer.

Surface Observation Data Pathway

TAPE FORMAT

Of the two formats available from NCDC, the MPDA-1 uses the format consisting of 80 characters per report that are blocked to 10 reports per physical tape record; it uses EBCDIC character format. NCDC provides the tape format document CD144, Surface Airways Observations, with requested data tapes. This document describes the data format in detail.

THE PROGRAMS

As illustrated in Figure 4.2, the surface observation data pathway consists of a series of four programs. These programs are called SCAN-SFC, EXTRACT-SFC, CONVERT-SFC, and QA-SFC. As for the radiosonde data pathway, the scan and QA programs are optional for the surface observation data pathway.

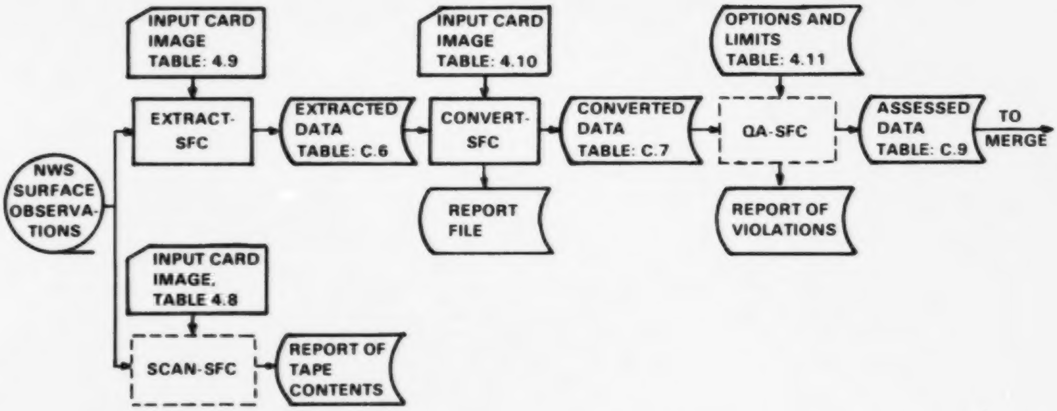

INPUT CARD IMAGE TABLE: 4.9
INPUT CARD IMAGE TABLE: 4.10
OPTIONS AND LIMITS TABLE: 4.11
EXTRACT-SFC
EXTRACTED DATA TABLE: C.6
CONVERT-SFC
CONVERTED DATA TABLE: C.7
QA-SFC
ASSESSED DATA TABLE: C.9
TO MERGE
NWS SURFACE OBSERVATIONS
REPORT FILE
REPORT OF VIOLATIONS
INPUT CARD IMAGE, TABLE 4.8
SCAN-SFC
REPORT OF TAPE CONTENTS

Figure 4.2. The surface observation data pathway in the preprocessor. Optional programs are indicated by dashed lines. Table numbers refer to tables in this section and Appendix C that specify format requirements.

INPUT CARD IMAGE AND FILE FORMAT REQUIREMENTS

SCAN-SFC--This optional program works the same as it does for radiosonde data; it surveys the original surface observation data set and reports the stations, days, and times recorded on the magnetic tape. Table 4.8 describes the user-supplied information required for the input card image of this program.

TABLE 4.8. INPUT CARD IMAGE FOR SCAN-SFC*

Record Type	Number of Records	Variable	Description	Units	Format/Type†
1	1	CHFMT	Option to convert EBCDIC to ASCII character format. Specify "ASCII" to perform the conversion; for no conversion, specify any other character string	—	C*5

* Logical unit numbers are assigned as follows: input = 10; output = 8.

† C = character (maximum length as shown).

EXTRACT-SFC--This program retrieves only those stations and days of interest to the user. Table 4.9 describes the user-supplied information required for the input card image of this program.

TABLE 4.9. INPUT CARD IMAGE FOR EXTRACT-SFC*

Record Type	Number of Records	Variable**	Description	Units	Format/Type†
1	1	IUSRST	Identifier of station to be extracted	—	I
		STLAT	Station latitude††	decimal degrees	R
		STLON	Station longitude††	decimal degrees	R
		IUSRYR	Last two digits of the year to be extracted	—	I
		JBEGIN	First Julian day of the year to be extracted	—	I
		JEND	Final Julian day of the year to be extracted	—	I
		TAPENO	Magnetic tape identification number-used only in an output descriptive header	—	C*6
		CHFMT	Option to convert EBCDIC to ASCII character format. Specify "ASCII" to perform the conversion; for no conversion, specify any other character string	—	C*5

* Logical unit numbers are assigned as follows: input = 7; output = 8.

** Variables must appear in the order shown.

† I = integer; R = real; C = character (maximum length is indicated).

†† Latitudes and longitudes for NWS stations may be found in National Weather Service, 1972.

CONVERT-SFC--This program converts the extracted surface observation data to the meteorological units required by the metprocessor. Table 4.10 describes the user-supplied information required for the input card image of this program.

TABLE 4.10. INPUT CARD IMAGE FOR CONVERT-SFC*

Record Type	Number of Records	Variable**	Description	Units	Format/Type†
1	1	IOPT9	Option to produce a file for MERGE: TRUE = produce a file FALSE = do not produce a file	—	L
		IOPT10	Option to produce a report file with all the data and additional headers: TRUE = produce the file FALSE = do not produce the file	—	L

* Logical unit numbers are assigned as follows: input = 8; output = 9; report file = 10.

** To produce a file for MERGE to use, IOPT9 must be set to TRUE. The report file, generated when IOPT10 is TRUE, contains all the output data plus several informational headers about the variables.

† L = logical.

QA-SFC--A NAMELIST-directed READ of the limits and options from a disk file created by the user attached to logical file 9 is used with this program, rather than a list-directed READ from an input card image (see Table 4.11). The NAMELIST group name that appears in the program is called TESTS. Consult your system's reference manual for the correct NAMELIST file format.

The input file to be evaluated is attached to logical file 10, the output file is attached to logical file 12, and the report of violations is attached to logical file 11. A more detailed description of this QA program is given in Section 6.

TABLE 4.11. INPUT FILE OF LIMITS FOR QA-SFC*

Record Type	Number of Records	Variable	Description	Units	Format/Type†
1	1	BLAT	Reference latitude	decimal degrees	R
		TMIN0	Lower limit for temperature at BLAT	°C	R
		TMAX0	Upper limit for temperature at BLAT	°C	R
		DTMNDL	Maximum allowable change with latitude of the lower limit for temperature	°C/degree	R
		DTMXDL	Maximum allowable change with latitude of the upper limit for temperature	°C/degree	R
		DMIN0	Lower limit for dew point at BLAT	°C	R
		DMAX0	Upper limit for dew point at BLAT	°C	R
		DDMNDL	Maximum allowable change with latitude of the lower limit for dew point	°C/degree	R
		DDMXDL	Maximum allowable change with latitude of the upper limit for dew point	°C/degree	R
		WSMAX	Upper limit for wind speed	m/s	R
		WSMIN	Lower limit for wind speed	m/s	R
		SLPMAX	Upper limit for sea level pressure	mb	R
		SLPMIN	Lower limit for sea level pressure	mb	R

---

* Violation reports can be suppressed by specifying the upper limits to 9999.0, the lower limits to -9999.0, and the changes with latitude to 0.0. This ensures that the checks are never violated.

† R = real.

On-Site Data Pathway

THE PROGRAM

Given the wide variability of possible formats for user-collected or acquired data, the preprocessor only includes a QA program for on-site data. This optional pathway is illustrated in Figure 4.3. Because of the variability in formats for this data type, the easiest way for the user to enter his data into the MPDA-1 system is to format it according to the specifications of the on-site QA program in the preprocessor.

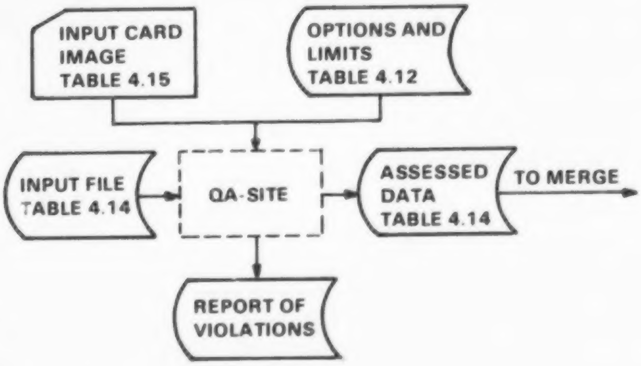

INPUT CARD IMAGE TABLE 4.15
OPTIONS AND LIMITS TABLE 4.12
INPUT FILE TABLE 4.14
QA-SITE
ASSESSED DATA TABLE 4.14
TO MERGE
REPORT OF VIOLATIONS

Figure 4.3. The on-site data pathway in the preprocessor. The dashed lines indicate that the program is optional. Table numbers refer to tables in this section that specify format requirements.

INPUT CARD IMAGE AND FILE FORMAT REQUIREMENTS

QA-SITE--The on-site data pathway provides the user with the ability to include additional variables of interest. In QA-SITE, the user specifies the variables to be evaluated through LOGICAL options. If a variable is to be evaluated, the user specifies whether to use the default limits or the limits he supplies. The options and limits are attached to logical file 9 and are read with a list-directed READ. The form of the file is shown in Table 4.12 and the variables, default values, and the order in which the information must appear in the file are shown in Table 4.13. The input file format is given in Table 4.14, and the input card image is described in Table 4.15.

The input file to be evaluated is attached to logical file 7, the output file is attached to logical file 12, and the report of violations is attached to logical file 10.

TABLE 4.12. OPTIONS AND LIMITS FILE FORMAT FOR QA-SITE

Record Type	Number of Records*	Variable**	Description	Units	Format/Type†
1	33-37	—	Identifier	—	C*20
		OPxxxx	Option to QA the variable: TRUE = assess variable FALSE = skip variable	—	L
		DFAULT	Option to use default limits or user-supplied limits: DFAULT = 0, default limits = 1, user-supplied limits	—	I
		LOxxxx	The minimum value the variable is checked against if the user is supplying the limits	variable-dependent	R
		HIxxxx	The maximum value the variable is checked against if the user is supplying the limits	variable-dependent	R

* The number of records will vary from 33 to 37 depending on the number of radiation bands (maximum of 5) to be assessed. A separate record is required for each band and should correspond to the number of bands in the user's data.

** The variable names for the option to QA and user-supplied limits differ for each variable but begin with OP, LO, or HI.

† C = character (maximum length shown); L = logical; I = integer; R = real.

TABLE 4.13. VARIABLE EVALUATED BY QA-SITE[*]

		Default Values	
Variable	Units	Minimum	Maximum
Surface roughness length[†]	m	0.0	1.0
Mixing height	m	0.0	2500.0
Surface heat flux	W/m^2	-200.0	200.0
Surface friction velocity	m/s	0.0	0.5
Wind gust	m/s	0.0	50.0
Liquid precipitation total	mm	0.0	50.0
Solid precipitation total	mm	0.0	50.0
Snow cover	cm	0.0	1.0
Temperature[†]	°C	-25.0	40.0
Dew point[†]	°C	-10.0	25.0
Atmospheric pressure	mb	900.0	1050.0
Density of air	kg/m^3	1.15	1.30
u-component of the wind	m/s	-25.0	25.0
v-component of the wind	m/s	-25.0	25.0
w-component of the wind	m/s	-1.0	1.0
User-specified	user-specified	-9999.0	9999.0
Wind speed[†]	m/s	0.0	35.0
Wind direction[†]	degrees from north	0.0	360.0
Relative humidity	%	10.0	100.0
Specific humidity	g/kg	1.0	5.0
σu	m/s	0.0	0.5
σv	m/s	0.0	0.5
σw	m/s	0.0	1.0
σwind speed	m/s	0.0	1.0
Mean elevation angle the wind vector makes with the horizon	degrees	-5.0	5.0
Standard deviation of wind direction in the vertical[†]	degrees	0.0	30.0
Standard deviation of wind direction in the horizontal[†]	degrees	0.0	45.0
σT	°C	0.0	0.25
σdew point	°C	0.0	0.25
σrelative humidity	%	0.0	5.0
σspecific humidity	g/kg	0.0	0.5
Temperature lapse rate	°C/m	-0.10	0.10
Irradiance[††] (maximum of 5 bands)	W/m^2	0.0	1500.0

[*] Variables are listed in the order in which they are found in the program.
[†] Variables (in the indicated units) used in the metprocessor.
[††] Default values for irradiance are for all wavelengths and types of radiation.

TABLE 4.14. INPUT FILE FORMAT FOR QA-SITE

Record Type	Number of Records	Variable(s)	Description	Units	Format/Type
1	1	IHDTR	Number of descriptive header records to follow (if there are none, a zero must be specified)	—	1X,I3
2	IHDTR	STRING	Descriptive headers	—	A72
3	1	JMO, JDA, JYR†	Month, day, year (last two digits)	LST	2X,3I2
		JDATE1	Julian date	—	2X,I5
		JTIME	Time of day (hours and minutes) on a 24-h clock	LST	2X,I10
		JSEC	Number of seconds past JTIME	—	2X,I6
		JHR†	Julian hour	LST	2X,I6
		NOHTS	Number of levels of on-site data	—	2X,I3
4	1	ZOVAL†	User-supplied value of surface roughness length	m	1X,F7.1
		ZIVAL†	User-supplied value of mixing height	m	1X,F7.1
		USRVAL†	User-supplied value of surface friction velocity	m/s	1X,F7.1
		HSFVAL†	User-supplied value of surface heat flux	W/m^2	1X,F7.1
		WG	Wind gust	m/s	1X,F7.1
		ILPT	Total liquid precipitation	mm	1X,F7.1
		ISPT	Total solid precipitation	mm	1X,F7.1
		ISNC	Snow cover	cm	1X,I5
		ISKY	Total sky cover	numeric descriptive code	1X,I5
5*	1	TMT†	Height	m	1X,F5.1
		TEMP†	Temperature	°C	F13.5
		STDTMP	Standard deviation of temperature	°C	F13.5
		WSP†	Wind speed	m/s	F13.5
		WSPSTD	Standard deviation of wind speed	m/s	F13.5
		WDIR†	Wind direction	degrees from north	F13.5
		SIGA†	Standard deviation of the wind direction in the horizontal	degrees	F13.5
		MEA	Mean elevation angle	degrees	F13.5

continued

TABLE 4.14. INPUT FILE FORMAT FOR QA-SITE (CONTINUED)

Record Type	Number of Records	Variable(s)	Description	Units	Format/Type
		SIGE†	Standard deviation of the wind direction in the vertical	degrees	F13.5
6*	1	TMT†	Height	m	1X,F5.1
		DEWPT†	Dew point	°C	F13.5
		PRESS†	Atmospheric pressure	mb	F13.5
		UCOMP	u-component of the wind	m/s	F13.5
		VCOMP	v-component of the wind	m/s	F13.5
		WCOMP	w-component of the wind	m/s	F13.5
		DENS	Density of air	kg/m^3	F13.5
		USRDEF	Open for use by user	—	F13.5
		RELHUM	Relative humidity	%	F13.5
7*	1	TMT†	Height	m	1X,F5.1
		SPHUM	Specific humidity	g/kg	F13.5
		SGUCOM	Standard deviation of the u-component of the wind	m/s	F13.5
		SGVCOM	Standard deviation of the v-component of the wind	m/s	F13.5
		SGWCOM	Standard deviation of the w-component of the wind	m/s	F13.5
		SIGD	Standard deviation of dew point	°C	F13.5
		STDRH	Standard deviation of relative humidity	%	F13.5
		STDSH	Standard deviation of specific humidity	g/kg	F13.5
8*	1	TMT	Height	m	1X,F5.1
		NOWVLN	Number of bands of radiation to follow	—	I2
9*	NOWVLN	WAVLEN	Wavelength	μm	F7.1
		RADFLX	Irradiance	W/m^2	1X,F13.5

* Record types 5 through 9 are repeated for the number of levels of on-site data (NOHTS). The formats established by record types 3 through 9 are repeated for each hour of on-site data.

† These variables are coded in some of the methods in the metprocessor with the units shown. The remaining variables are not in use currently. The default values in the QA program are based on the units shown.

TABLE 4.15. INPUT CARD IMAGE FOR QA-SITE

Record Type	Number of Records	Variable*	Description	Units	Format/Type†
1	1	IMOST	First month of data to QA	—	I
		IMOEND	Final month of data to QA	—	I
		NOWVLN	Number of radiation wavelengths reported in the data	—	I

* Variables must be listed in the order shown.

† I = integer.

MERGE

The MERGE program combines the three types of data into one file for use by the metprocessor. If one or more of the data types is not available, the MERGE program will interpret empty files as missing data. During the MERGE process, a missing value indicator (-9999.0 or -9999) is inserted into the output file for all variables with missing data. Table 4.16 describes the user-supplied information required for the input card images of the MERGE program.

NOTE: The station latitude and longitude specified here are used in the computation of the solar elevation. Solar elevation is used in several of the metprocessor routines, including those for surface heat flux and friction velocity.

TABLE 4.16. INPUT CARD IMAGES FOR MERGE

Record Type	Number of Records	Variable	Description	Units	Format/Type**
1	1	JBEGIN	Initial Julian day to merge	—	I
		JEND	Final Julian day to merge	—	I
		ALON	Station longitude	decimal degrees	R
		ALAT	Station latitude	decimal degrees	R
		WROPT	Option to write a formatted output file: TRUE = write a formatted file FALSE = do not write a formatted file	—	L
		NUMBER	Number of ordered triples of terrain classes (Table 3, Section 3) to follow	—	I
2	NUMBER	TER1, TER2, TER3	The terrain classes, with the most dominant class appearing first	—	I

* Logical unit numbers are assigned as follows: radiosonde input = 15; surface observation input = 17; on-site input = 16; formatted output = 24; unformatted output = 25.

** R = real; I = integer; L = logical.

METPROCESSOR

The Program

The metprocessor consists of one main program (DRIVER) and a number of subroutines. DRIVER reads the merged file of data, initializes variables, and controls the execution of the subroutines. Each subroutine computes either a meteorological surface parameter (e.g., surface heat flux), a mixing height, or constructs a one-dimensional profile of a meteorological variable (e.g., temperature). The results are written to the output file.

Input Card Image and File Format Requirements

To execute the metprocessor, the user must choose a method for computing a parameter or profile. The user controls the method by which each variable will be specified, as shown in Table 4.17. In essence, the user controls which subroutine is called for each variable. If a number is specified that does not correspond to a method, that parameter or profile will not be computed and will be considered missing for all times. Refer to Section 3 for a technical discussion of each of the methods.

The output subroutines (OUT3 and OUT4) both process the descriptive header information from the input file and the descriptive header for each of the selected methods. OUT3 displays all the input data and all the results of the methods. OUT4 writes descriptive headers and results (unformatted) for use by the TUPOS diffusion model. Appendix D shows the structure of the output from OUT4.

The input file is attached to logical file 25, and the output is attached to logical file 8. The file with the error messages written during execution of the metprocessor is attached to logical file 9. A summary table of the error messages, by subroutine, is written to the system output device (logical file 6 on the UNIVAC).

TABLE 4.17. INPUT CARD IMAGE FOR THE METPROCESSOR

Record Type	Number of Records	Selection Variable	Description and Selection Constant	Units	Format/Type*
1	1	FSELN	Surface layer similarity function for momentum in a stable atmosphere 1: log-linear 2: semi-empirical extension of log-linear (Holtslag, 1984)	—	I
		DYBU	Option to use Dyer and Hicks (1970) or Businger *et al*. (1971) surface layer similarity constants 1: Dyer and Hicks 2: Businger	—	I
		ZOMOD	Surface roughness length, z_0 1: ZOMOD1 2: ZOMOD2	—	I
		HMOD	Surface heat flux, H_0 1: HMOD1 3: HMOD3 4: HMOD4	—	I
		USMOD	Surface friction velocity, u_* 1: USMOD1 3: USMOD3 4: USMOD4	—	I
		LMOD	Monin-Obukhov length, L 2: LMOD2	—	I
		ZICMOD	Convective mixed layer height, z_c 1: ZCMOD1 2: ZCMOD2 3: ZCMOD3	—	I
		ZIMMOD	Mechanical mixed layer height, z_m 1: ZMMOD1 2: ZMMOD2 3: ZMMOD3	—	I
		HMOD	Profile heights 1: HTMOD1 2: HTMOD2	—	I
		TMPMOD	Temperature profile 1: TMOD1	—	I
		UVMOD	Wind profile - u- and v- components 2: UVMOD2 3: UVMOD3 4: UVMOD4	—	I

continued

TABLE 4.17. INPUT CARD IMAGE FOR THE METPROCESSOR (CONTINUED)

Record Type	Number of Records	Selection Variable	Description and Selection Constant	Units	Format/Type*
		SWMOD	Profile of vertical wind fluctuations 1: SWMOD1 2: SWMOD2	—	I
		SVMOD	Profile of the horizontal wind fluctuations 1: SVMOD1 2: SVMOD2	—	I
		OUTMOD	Output listing style 3: OUT3 4: OUT4	—	I
		NHTS	The number of heights in the profile	—	I
		USRHTS	An array of length NHTS containing either absolute height above the surface (to be used if HTMOD = 1) or fractions of the mixing height (used if HTMOD = 2)	m or unitless	R

* I = integer; R = real.

SECTION 5

SAMPLE PROBLEM

INTRODUCTION

A sample problem using the MPDA-1 system is presented, beginning with the preprocessor scans of the NWS radiosonde and surface observation tapes and proceeding along the data pathways. On-site data are quality-assessed, and the three files are merged into one file. Results are from the processing of one month of data (February, 1976). Data are from locations in Georgia: radiosonde data are from Athens, surface observation data are from Augusta, and on-site data were provided by the Savannah River Laboratory. The figures in this section show the program and data file names used in this example and correspond to those in the data pathway diagrams in Figures 4.1, 4.2, and 4.3 in Section 4. The sample problem concludes with a sample execution of the metprocessor.

For each program presented here, the UNIVAC Executive Control Language (ECL) used to execute each program (runstream) is shown, along with a portion of the output file(s). The QA programs require a small second file of input information in addition to the input data. These are shown also. The information for the input card image is located immediately after the statement that initiates program execution (@XQT).

A few of the other ECL commands include assigning files to the run (@ASG), attaching the files to the logical file numbers (@USE), and skipping files on the magnetic tape (@MOVE).

Information regarding run time and memory requirements for each of the programs can be found in Table 7.1 in Section 7. Section 7 also describes the configuration of the NTIS tape and the nonstandard FORTRAN used in the MPDA-1. Error messages are described in Appendix E. This section concludes with five checklists that are designed to be copied and used as the user works through the system.

RADIOSONDE DATA PATHWAY

Figure 5.1 illustrates the radiosonde data pathway using the program and data file names from this sample problem.

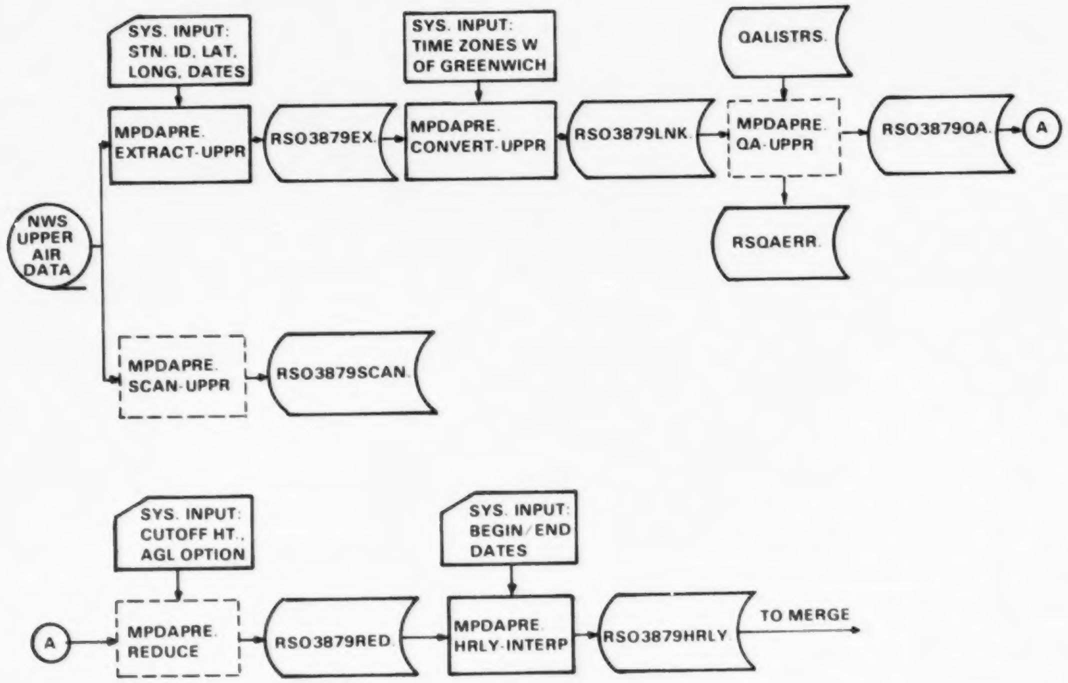
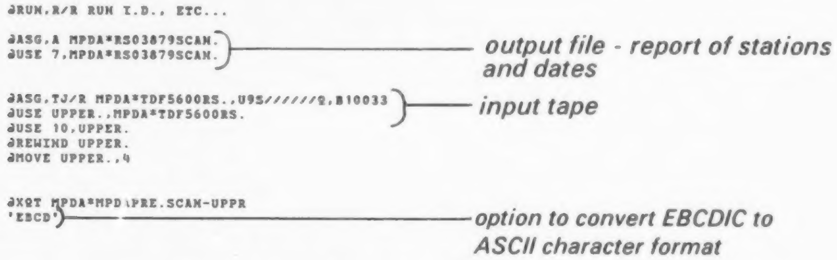

SYS. INPUT: STN. ID, LAT, LONG, DATES
SYS. INPUT: TIME ZONES W OF GREENWICH
QALISTRS.
MPDAPRE. EXTRACT-UPPR
RSO3879EX.
MPDAPRE. CONVERT-UPPR
RSO3879LNK.
MPDAPRE. QA-UPPR
RSO3879QA.
A
NWS UPPER AIR DATA
RSQAERR.
MPDAPRE. SCAN-UPPR
RSO3879SCAN.
SYS. INPUT: CUTOFF HT., AGL OPTION
SYS. INPUT: BEGIN/END DATES
A
MPDAPRE. REDUCE
RSO3879RED.
MPDAPRE. HRLY-INTERP
RSO3879HRLY.
TO MERGE

Figure 5.1. The radiosonde data pathway. Program and data file names are from the sample problem.

SCAN-UPPR

The following runstream (Figure 5.2) initiates the scanning of a magnetic tape. The magnetic tape is attached to the name UPPER for use by ATAPE and to logical file 10 to retrieve the name of the tape from the @ASG statement. Logical file number 7 is used for the output (report) file. The tape is moved past four EOF marks to scan the correct file. Table 4.1 in Section 4 describes the input card image.

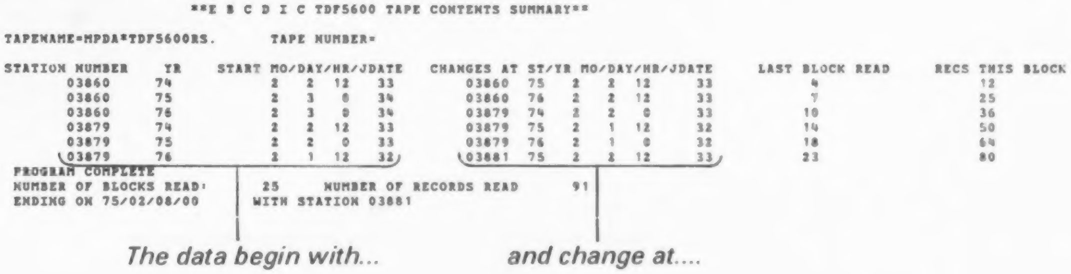


```
@RUN,R/R RUN I.D., ETC...

@ASG,A MPDA*RS03879SCAN.
@USE 7,MPDA*RS03879SCAN.

@ASG,TJ/R MPDA*TDF5600RS.,U9S//////Q,B10033
@USE UPPER.,MPDA*TDF5600RS.
@USE 10,UPPER.
@REWIND UPPER.
@MOVE UPPER.,4

@XQT MPDA*MPDAPRE.SCAN-UPPR
'EBCD'
```

output file - report of stations and dates
input tape
option to convert EBCDIC to ASCII character format

Figure 5.2. Runstream for SCAN-UPPR. Table 4.1 in Section 4 describes the input card image.

The report from the scanning routine (MPDA*RS03879SCAN.) has the form illustrated in Figure 5.3. The stations and years contained on the tape are reported. A record is written whenever a station identifier or year changes.



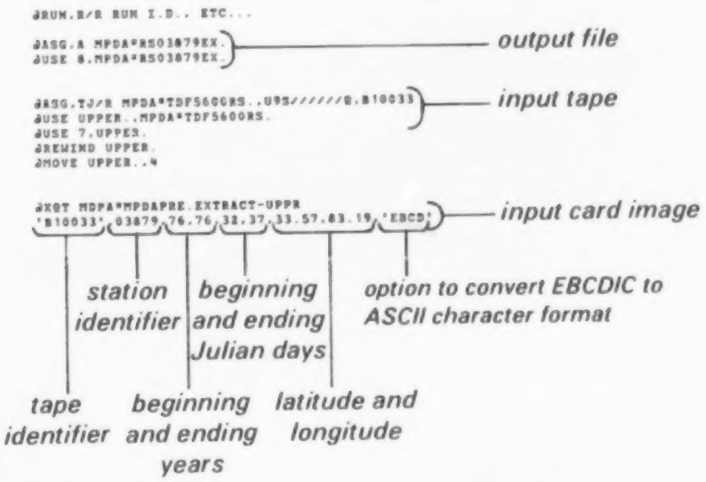
```
                    **E B C D I C TDF5600 TAPE CONTENTS SUMMARY**

TAPENAME=MPDA*TDF5600RS.     TAPE NUMBER=

STATION NUMBER    YR     START MO/DAY/HR/JDATE   CHANGES AT ST/YR MO/DAY/HR/JDATE     LAST BLOCK READ     RECS THIS BLOCK
      03860       74             2   2  12   33        03860  75   2   2  12    33           4                  12
      03860       75             2   3   0   34        03860  76   2   2  12    33           7                  25
      03860       76             2   3   0   34        03879  74   2   2   0    33          10                  36
      03879       74             2   2  12   33        03879  75   2   1  12    32          14                  50
      03879       75             2   2   0   33        03879  76   2   1   0    32          18                  64
      03879       76             2   1  12   32        03881  75   2   2  12    33          23                  80
 PROGRAM COMPLETE
 NUMBER OF BLOCKS READ:    25     NUMBER OF RECORDS READ       91
 ENDING ON 75/02/08/00     WITH STATION 03881
```

Figure 5.3. Report from SCAN-UPPR.

The cumulative total of the number of physical records and radiosonde reports is also written.

EXTRACT-UPPR

The magnetic tape is attached to the name UPPER for use by ATAPE and to logical file 7 to retrieve the name of the tape from the @ASG statement. Logical file number 8 is used for the output (MPDA*RS03879EX.) file of EXTRACT-UPPR. The tape is moved past four EOF marks to read the correct data file. The runstream is illustrated in Figure 5.4. The input card image is described in Table 4.2 of Section 4. Only one station, with identifier 03879, is extracted. Because the "76" is the same in both the beginning and ending year positions, only 1976 data are extracted. Data from February 1 (Julian day 32) to February 5 (Julian day 37) are the days extracted.

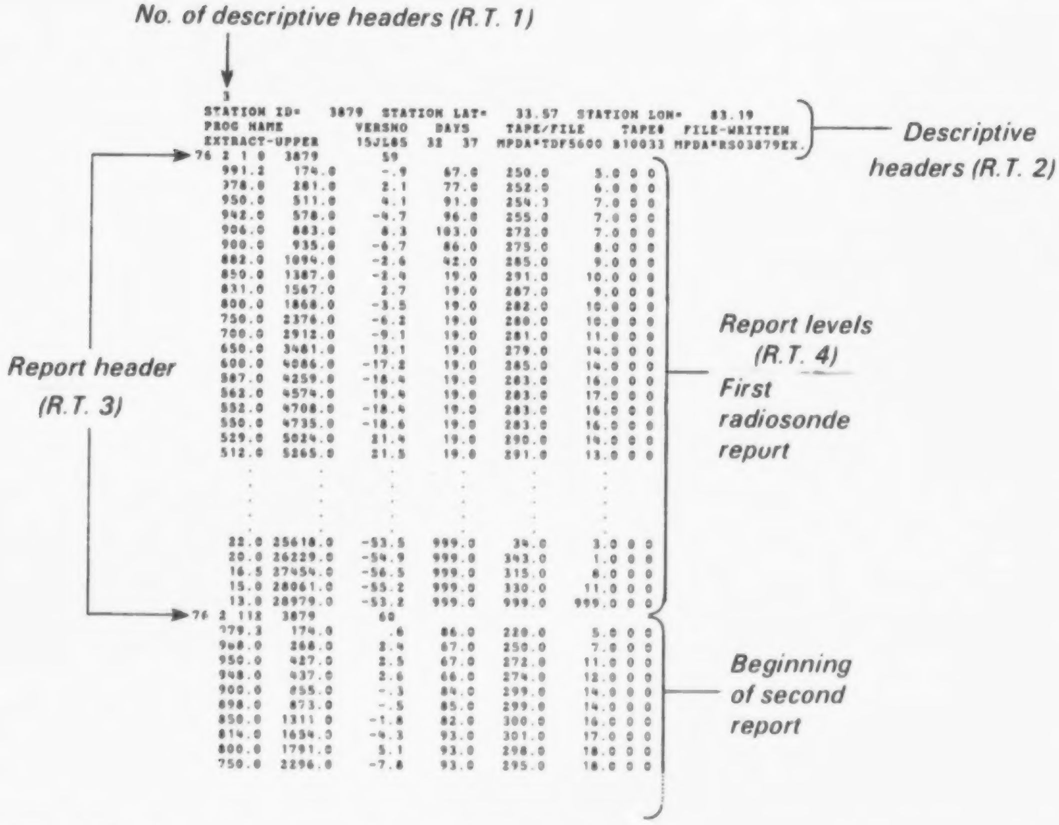


```
@RUN.R/R RUN I.D., ETC...

@ASG.A MPDA*RS03879EX.
@USE 8.MPDA*RS03879EX.

@ASG.TJ/R MPDA*TDF5600RS.,U9S//////R.B10033
@USE UPPER.,MPDA*TDF5600RS.
@USE 7.UPPER.
@REWIND UPPER.
@MOVE UPPER.,4

@XQT MDPA*MPDAPRE.EXTRACT-UPPR
'B10033',03879,76.76,32.37,33.57.83.19,'EBCD'
```

output file
input tape
input card image
station identifier
beginning and ending Julian days
option to convert EBCDIC to ASCII character format
tape identifier
beginning and ending years
latitude and longitude

Figure 5.4. Runstream for EXTRACT-UPPR. Table 4.2 in Section 4 describes the input card image for this program.

An annotated sample of the output file is shown in Figure 5.5. The file is comprised of approximately 3400 lines.



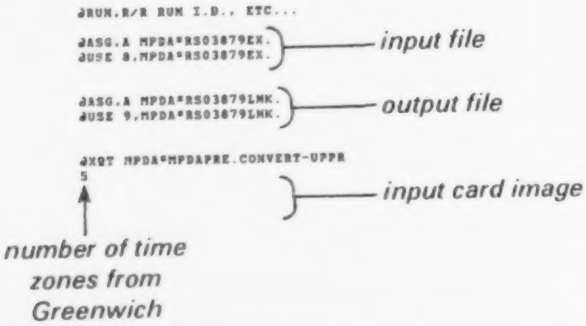
```
3
STATION ID=   3879  STATION LAT=   33.57  STATION LON=   83.19
PROG NAME           VERSNO   DAYS    TAPE/FILE     TAPE#  FILE-WRITTEN
EXTRACT-UPPER       15JL85  32  37  MPDA*TDF5600 B10033 MPDA*RS03879EX.
76  2  1  0   3879        59
    991.2     174.0      -.9     67.0   250.0      5.0  0  0
    978.0     281.0      2.1     77.0   252.0      6.0  0  0
    950.0     511.0      4.1     91.0   254.3      7.0  0  0
    942.0     578.0     -4.7     96.0   255.0      7.0  0  0
    906.0     883.0      8.3    103.0   272.0      7.0  0  0
    900.0     935.0     -6.7     86.0   275.0      8.0  0  0
    882.0    1094.0     -2.6     42.0   285.0      9.0  0  0
    850.0    1387.0     -2.4     19.0   291.0     10.0  0  0
    831.0    1567.0      2.7     19.0   287.0      9.0  0  0
    800.0    1868.0     -3.5     19.0   282.0     10.0  0  0
    750.0    2376.0     -6.2     19.0   280.0     10.0  0  0
    700.0    2912.0     -9.1     19.0   281.0     11.0  0  0
    650.0    3481.0     13.1     19.0   279.0     14.0  0  0
    600.0    4086.0    -17.2     19.0   285.0     14.0  0  0
    587.0    4259.0    -18.4     19.0   283.0     16.0  0  0
    562.0    4574.0     19.4     19.0   283.0     17.0  0  0
    552.0    4708.0    -18.4     19.0   283.0     16.0  0  0
    550.0    4735.0    -18.6     19.0   283.0     16.0  0  0
    529.0    5024.0     21.4     19.0   290.0     14.0  0  0
    512.0    5265.0     21.5     19.0   291.0     13.0  0  0
      .         .        .        .       .         .
      .         .        .        .       .         .
      .         .        .        .       .         .
      .         .        .        .       .         .
      .         .        .        .       .         .
     22.0   25618.0    -53.5    999.0    34.0      3.0  0  0
     20.0   26229.0    -54.9    999.0   343.0      1.0  0  0
     16.5   27454.0    -56.5    999.0   315.0      8.0  0  0
     15.0   28061.0    -55.2    999.0   330.0     11.0  0  0
     13.0   28979.0    -53.2    999.0   999.0    999.0  0  0
76  2 112   3879        60
    979.3     174.0       .6     86.0   220.0      5.0  0  0
    968.0     268.0      2.4     67.0   250.0      7.0  0  0
    950.0     427.0      2.5     67.0   272.0     11.0  0  0
    948.0     437.0      2.6     66.0   274.0     12.0  0  0
    900.0     855.0      -.3     84.0   299.0     14.0  0  0
    898.0     873.0      -.5     85.0   299.0     14.0  0  0
    850.0    1311 0     -1.8     82.0   300.0     16.0  0  0
    814.0    1654.0     -4.3     93.0   301.0     17.0  0  0
    800.0    1791.0      5.1     93.0   298.0     18.0  0  0
    750.0    2296.0     -7.8     93.0   295.0     18.0  0  0
```

No. of descriptive headers (R.T. 1)
Descriptive headers (R.T. 2)
Report header (R.T. 3)
Report levels (R.T. 4)
First radiosonde report
Beginning of second report

Figure 5.5. Sample of output file from EXTRACT-UPPR. R.T. = record type; refer to Table C.1 in Appendix C for more information.

CONVERT-UPPR

Logical file numbers 8 and 9 are used for the input (MPDA*RS03879EX.) and output (MPDA*RS03879LNK.) files, respectively, for CONVERT-UPPR. The input card image (Table 4.3, Section 4) consists of one number, the number of time zones from Greenwich, as given in Table 4.4 in Section 4. Figure 5.6 illustrates the runstream.

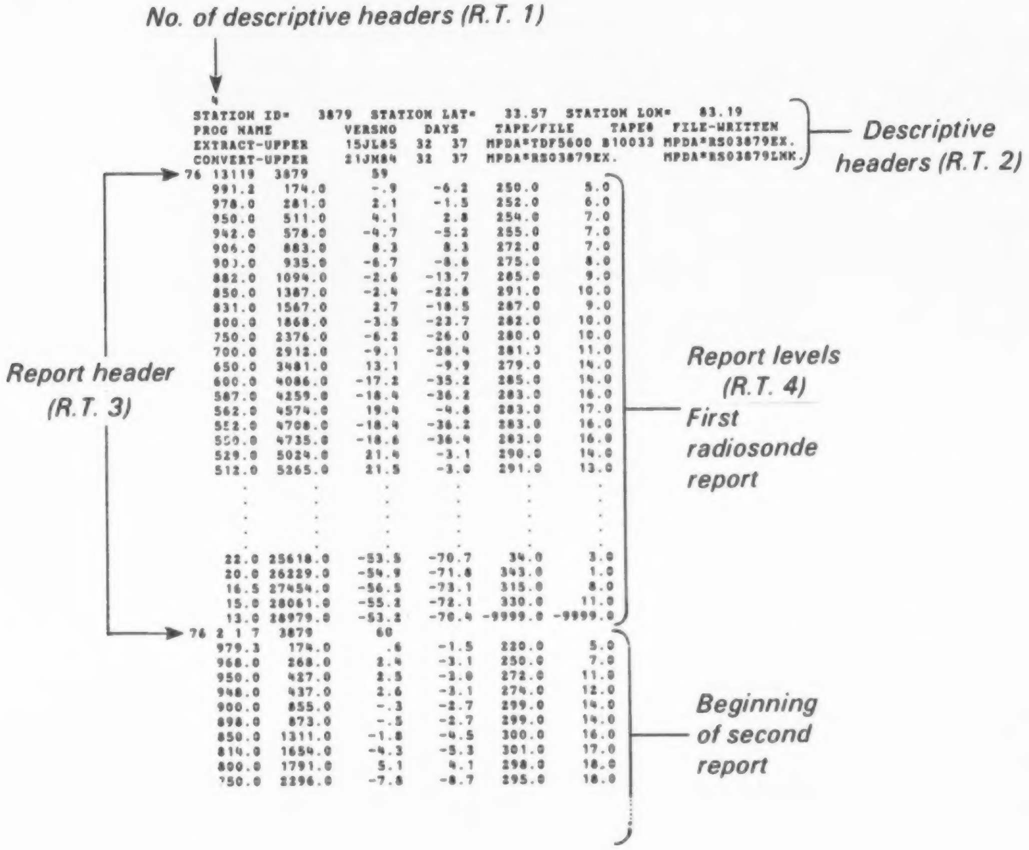


```
@RUN,R/R RUN I.D., ETC...

@ASG,A MPDA*RS03879EX.
@USE 8,MPDA*RS03879EX.

@ASG,A MPDA*RS03879LNK.
@USE 9,MPDA*RS03879LNK.

@XQT MPDA*MPDAPRE.CONVERT-UPPR
5
```

input file
output file
input card image
number of time zones from Greenwich

Figure 5.6. Runstream for CONVERT-UPPR. Table 4.3 in Section 4 describes the input card image.

An annotated sample of the output file is shown in Figure 5.7. The relative humidity has been converted to dew point temperature and the two flags have been dropped.

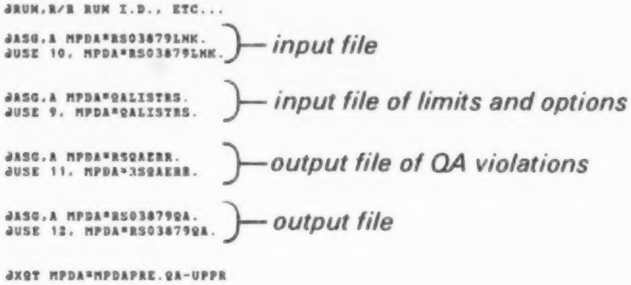

No. of descriptive headers (R.T. 1)
Descriptive headers (R.T. 2)
Report header (R.T. 3)
Report levels (R.T. 4)
First radiosonde report
Beginning of second report

```
 4
STATION ID=   3879  STATION LAT=   33.57  STATION LON=   83.19
PROG NAME          VERSNO   DAYS    TAPE/FILE    TAPE#  FILE-WRITTEN
EXTRACT-UPPER      15JL85  32  37  MPDA*TDF5600 B10033 MPDA*RS03879EX.
CONVERT-UPPER      21JN84  32  37  MPDA*RS03879EX.      MPDA*RS03879LNK.
76 13119  3879          59
    991.2    174.0      -.9     -6.2    250.0     5.0
    978.0    281.0      2.1     -1.5    252.0     6.0
    950.0    511.0      4.1      2.8    254.0     7.0
    942.0    578.0     -4.7     -5.2    255.0     7.0
    906.0    883.0      8.3      8.3    272.0     7.0
    903.0    935.0     -6.7     -8.6    275.0     8.0
    882.0   1094.0     -2.6    -13.7    285.0     9.0
    850.0   1387.0     -2.4    -22.8    291.0    10.0
    831.0   1567.0      2.7    -18.5    287.0     9.0
    800.0   1868.0     -3.5    -23.7    282.0    10.0
    750.0   2376.0     -6.2    -26.0    280.0    10.0
    700.0   2912.0     -9.1    -28.4    281.0    11.0
    650.0   3481.0     13.1     -9.9    279.0    14.0
    600.0   4086.0    -17.2    -35.2    285.0    14.0
    587.0   4259.0    -18.4    -36.2    283.0    16.0
    562.0   4574.0     19.4     -4.8    283.0    17.0
    552.0   4708.0    -18.4    -36.2    283.0    16.0
    550.0   4735.0    -18.6    -36.4    283.0    16.0
    529.0   5024.0     21.4     -3.1    290.0    14.0
    512.0   5265.0     21.5     -3.0    291.0    13.0
      .        .        .        .        .       .
      .        .        .        .        .       .
      .        .        .        .        .       .
      .        .        .        .        .       .
      .        .        .        .        .       .
     22.0  25618.0    -53.5    -70.7     34.0     3.0
     20.0  26229.0    -54.9    -71.8    343.0     1.0
     16.5  27454.0    -56.5    -73.1    315.0     8.0
     15.0  28061.0    -55.2    -72.1    330.0    11.0
     13.0  28979.0    -53.2    -70.4  -9999.0 -9999.0
76 2 1 7  3879          60
    979.3    174.0       .6     -1.5    220.0     5.0
    968.0    268.0      2.4     -3.1    250.0     7.0
    950.0    427.0      2.5     -3.0    272.0    11.0
    948.0    437.0      2.6     -3.1    274.0    12.0
    900.0    855.0      -.3     -2.7    299.0    14.0
    898.0    873.0      -.5     -2.7    299.0    14.0
    850.0   1311.0     -1.8     -4.5    300.0    16.0
    814.0   1654.0     -4.3     -5.3    301.0    17.0
    800.0   1791.0      5.1      4.1    298.0    18.0
    750.0   2296.0     -7.8     -8.7    295.0    18.0
```

Figure 5.7. Sample of output file from CONVERT-UPPR. R.T. = record type; refer to Table C.3 in Appendix C for more information.

QA-UPPR

A more detailed description of this program appears in Section 6. Logical file numbers 10 and 12 are used for the primary input (MPDA*RS03879LNK.) and output (MPDA*RS03879QA.) files. In addition to the two primary files, secondary input and output files are required to execute the program. The list of options and limits for the evaluation is attached to logical unit 9, and the report of violations is attached to logical file 11. There are no input card images. Figure 5.8 illustrates the runstream.



```
@RUN,R/R RUN I.D., ETC...

@ASG,A MPDA*RS03879LNK.
@USE 10, MPDA*RS03879LNK.

@ASG,A MPDA*QALISTRS.
@USE 9, MPDA*QALISTRS.

@ASG,A MPDA*RSQAERR.
@USE 11, MPDA*RSQAERR.

@ASG,A MPDA*RS03879QA.
@USE 12, MPDA*RS03879QA.

@XQT MPDA*MPDAPRE.QA-UPPR
```

input file
input file of limits and options
output file of QA violations
output file

Figure 5.8. Runstream for QA-UPPR. Table 4.7 in Section 4 describes the input card image.

The options and limits, described in more detail in Section 4, are shown in Figure 5.9 in the NAMELIST-directed READ format required by the Sperry UNIVAC. This format is described in more detail in Section 7. The user should consult his system reference manual for the applicability of this format.

```
 $TESTS
   TSUPR = -0.015,
   TINVR =  0.03,
   WSHR  =  0.05,
   CALM  = .TRUE.,
   WSMX  =  50.0,
   DPD   =  0.20,
   TDPFIL = .TRUE.,
   IFORM = 2
$END
```

Figure 5.9. Limits and options for QA-UPPR. Table 4.5 in Section 4 describes this file.

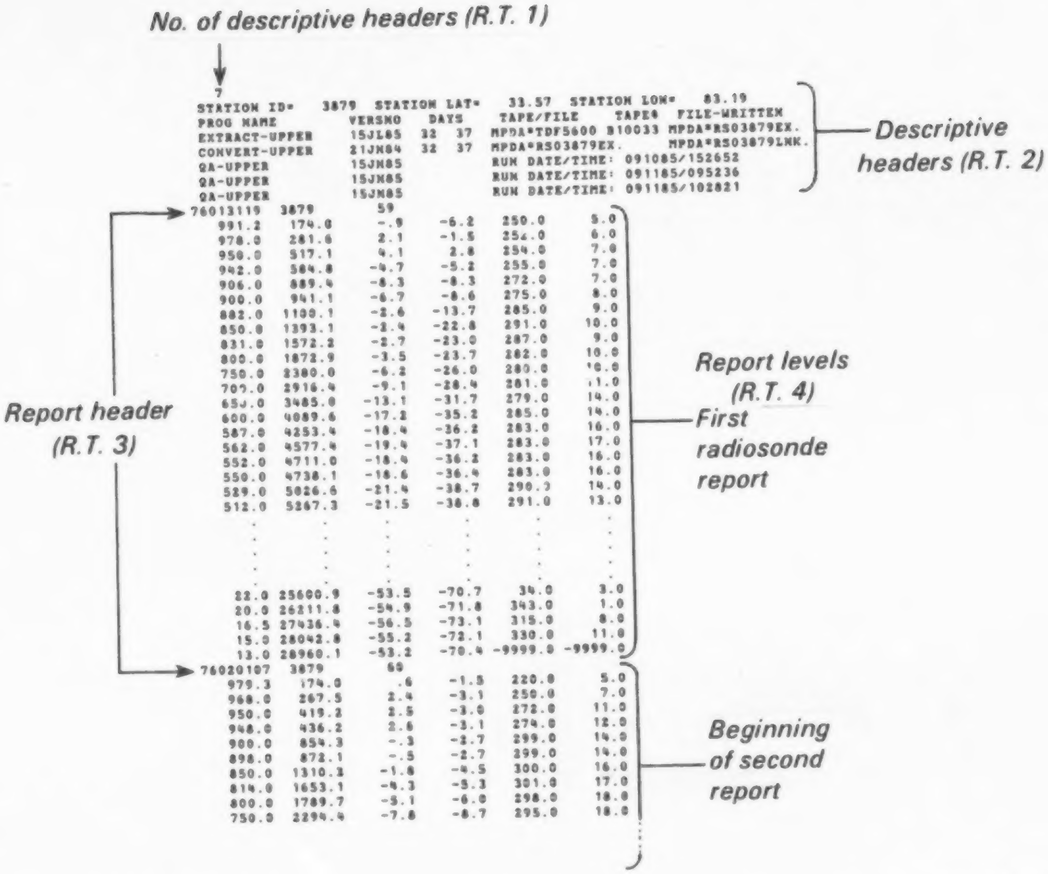
A portion of the list of violations (RSQAERR.) is shown in Figure 5.10. The first field contains the year, month, day, and hour; the second is the station identifier; the first two digits in the third field represent the level at which a violation was detected, and the last two digits represent the total number of levels in the radiosonde report. The next six fields are pressure, height, temperature, dew point, wind direction, and wind speed. The last field(s) contain code word(s) for the type(s) of violation(s). SUPR and TINV represent minimum and maximum lapse rate violations, respectively; WSHR and WSMX represent wind shear and wind speed violations; TDEW represents changes in dew point that are too great; and CALM represents a non-zero direction with a zero wind speed. Wind direction is reset to zero for these cases.

The code, SIGN, indicates an error in the sign of the temperature value. The program automatically changes the sign of temperature (field 6) and recomputes the dew point (field 7). The changed record is written to the report file.

In our sample problem, we executed the QA program three times, hence the three nearly identical descriptive headers. The QA program is rerun until there are no violations or until the user is satisfied that the records reported contain reasonable values and do not represent bad data. An annotated sample of the output file (MPDA*RS03879QA.) is shown in Figure 5.11.

```
76013119  3879 0459   942.0   584.8    -4.7    -5.2   255.0      7.0 SUPR
76013119  3879 0559   906.0   899.4     8.3     8.3   272.0      7.0 TDEW  TINV
76013119  3879 0659   900.0   952.8    -6.7    -8.6   275.0      8.0 TDEW  SUPR
76013119  3879 1059   800.0  1889.4    -3.5   -23.7   282.0     10.0 SUPR
76013119  3879 1359   650.0  3501.5   -13.1   -31.7   279.0     14.0 SIGN
76013119  3879 1659   562.0  4593.9   -19.4   -37.1   283.0     17.0 SIGN
76013119  3879 1959   529.0  5043.2   -21.4   -38.7   290.0     14.0 SIGN
76013119  3879 2059   512.0  5283.9   -21.5   -38.8   291.0     13.0 SIGN
76013119  3879 2459   384.0  7330.6   -39.3   -50.5   309.0     19.0 SIGN
76013119  3879 2559   358.0  7805.8   -43.9   -62.8   311.0     19.0 SIGN
76013119  3879 3059   250.0 10165.1   -54.1   -71.2   266.0     26.0 SIGN
76013119  3879 3859   150.0 13432.6   -53.3   -70.5   275.0     14.0 SIGN
76020107  3879 0460   948.0   436.2     2.6    -3.1   274.0     12.0 WSHR
76020107  3879 0960   800.0  1792.5     5.1     4.1   298.0     18.0 TINV
76020107  3879 1060   750.0  2307.3    -7.8    -8.7   295.0     18.0 SUPR
76020107  3879 1760   600.0  4007.3   -19.8   -35.1   303.0     14.0 SIGN
76020107  3879 1960   561.0  4502.7   -23.4   -29.3   302.0     16.0 SIGN
76020107  3879 2060   550.0  4647.1   -24.9   -30.7   301.0     16.0 SIGN
76020107  3879 2860   350.0  7775.0   -46.3   -64.8   264.0     17.0 SIGN
76020107  3879 2960   326.0  8248.6   -44.5   -63.3   261.0     19.0 SIGN
76020107  3879 4960    50.0 20378.7   -56.5   -73.2   345.0      7.0 SIGN
76020107  3879 5460    20.0 26182.0   -55.6   -72.4     4.0     12.0 SIGN
76020107  3879 5660    15.0 28025.1   -55.2   -72.1   347.0     12.0 SIGN
76020119  3879 0564   900.0   924.3    10.5     6.1   336.0     15.0 TINV
76020119  3879 0664   872.0  1176.8   -12.4   -13.4   336.0     15.0 SUPR
76020119  3879 1264   797.0  1857.0   -16.9   -34.9   330.0     21.0 SIGN  SUPR
76020119  3879 1364   791.0  1914.0   -14.6   -33.0   329.0     22.0 TINV
76020119  3879 1564   750.0  2318.4   -13.9   -32.4   333.0     27.0 SIGN  SUPR
76020119  3879 1864   600.0  3981.8   -23.7   -40.7   326.0     26.0 SIGN
76020119  3879 3264   250.0  9985.6   -46.8   -65.2   302.0     18.0 SIGN
76020119  3879 3364   225.0 10686.3   -45.1   -63.8   305.0     18.0 SIGN
76020119  3879 4764    87.0 16899.5   -54.2   -71.3   295.0     12.0 SIGN
76020119  3879 5364    52.0 20169.2   -58.5   -74.8   341.0      7.0 SIGN
76020119  3879 5564    45.0 21087.9   -54.6   -71.6   343.0      9.0 SIGN
76020119  3879 5764    37.0 22336.1   -46.7   -73.3    26.0      8.0 SIGN
76020207  3879 0461   921.0   750.9   -16.8   -18.4   354.0      1.0 TDEW
76020207  3879 1661   645.0  3456.5   -20.9   -31.1   315.0     22.0 SIGN  SUPR
76020207  3879 3261   276.0  9254.8   -50.9   -68.5   295.0     37.0 SIGN
76020207  3879 4361   114.0 15101.7   -52.5   -69.8   287.0     14.0 SIGN
76020207  3879 4861    70.0 18231.7   -57.8   -74.2   276.0      9.0 SIGN
76020207  3879 4961    63.0 19204.4   -57.4   -73.9   313.0     10.0 SIGN
76070207  3879 5061    56.0 19640.4   -57.1   -73.6   330.0      8.0 SIGN
76020207  3879 5361    46.0 20892.1   -57.5   -74.0   352.0      5.0 SIGN
76020207  3879 6161    11.0 30014.5   -57.9   -74.3 -9999.0  -9999.0 SIGN
76020219  3879 0456   960.0   445.6    11.7    11.4    93.0      3.0 TDEW  TINV
76020219  3879 0556   950.0   529.8   -10.9   -11.2    96.0      3.0 SUPR
76020219  3879 1256   794.0  1904.6   -13.5   -13.5 -9999.0  -9999.0 TDEW
76020219  3879 1356   793.5  1908.6   -99.9  -109.7 -9999.0  -9999.0 TDEW  SUPR
76020219  3879 1456   767.0  2125.4   -10.7   -16.0 -9999.0  -9999.0 TDEW  TINV
76020219  3879 2256   516.0  5059.6   -30.8   -33.4   309.0     17.0 SIGN
```

Figure 5.10. Partial list of QA-UPPR violations on the first pass through the data.



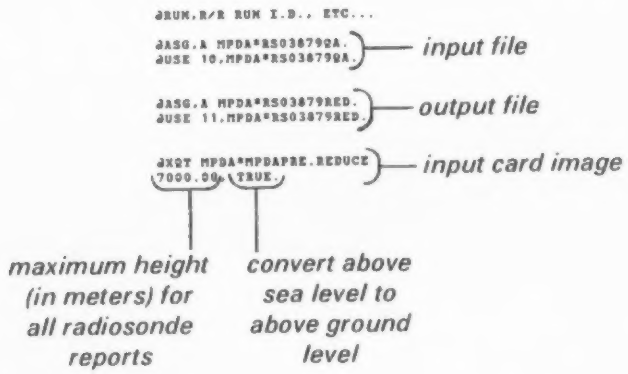
No. of descriptive headers (R.T. 1)
Descriptive headers (R.T. 2)
Report header (R.T. 3)
Report levels (R.T. 4)
First radiosonde report
Beginning of second report

```
7
STATION ID=   3879  STATION LAT=    33.57  STATION LON=   83.19
PROG NAME            VERSNO   DAYS    TAPE/FILE     TAPE#  FILE-WRITTEN
EXTRACT-UPPER        15JL85   32   37  MPDA*TDF5600 B10033 MPDA*RS03879EX.
CONVERT-UPPER        21JN84   32   37  MPDA*RS03879EX.      MPDA*RS03879LNK.
QA-UPPER             15JN85            RUN DATE/TIME: 091085/152652
QA-UPPER             15JN85            RUN DATE/TIME: 091185/095236
QA-UPPER             15JN85            RUN DATE/TIME: 091185/102821
76013119   3879          59
    991.2    174.0      -.9     -6.2    250.0      5.0
    978.0    281.6      2.1     -1.5    254.0      6.0
    950.0    517.1      4.1      2.8    254.0      7.0
    942.0    584.8     -4.7     -5.2    255.0      7.0
    906.0    889.4     -8.3     -8.3    272.0      7.0
    900.0    941.1     -6.7     -8.6    275.0      8.0
    882.0   1100.1     -2.6    -13.7    285.0      9.0
    850.0   1393.1     -2.4    -22.8    291.0     10.0
    831.0   1572.2     -2.7    -23.0    287.0      9.0
    800.0   1872.9     -3.5    -23.7    282.0     10.0
    750.0   2380.0     -6.2    -26.0    280.0     10.0
    700.0   2916.4     -9.1    -28.4    281.0     11.0
    650.0   3485.0    -13.1    -31.7    279.0     14.0
    600.0   4089.6    -17.2    -35.2    285.0     14.0
    587.0   4253.4    -18.4    -36.2    283.0     16.0
    562.0   4577.4    -19.4    -37.1    283.0     17.0
    552.0   4711.0    -18.4    -36.2    283.0     16.0
    550.0   4738.1    -18.6    -36.4    283.0     16.0
    529.0   5026.6    -21.4    -38.7    290.0     14.0
    512.0   5267.3    -21.5    -38.8    291.0     13.0
      .        .        .        .        .        .
      .        .        .        .        .        .
      .        .        .        .        .        .
      .        .        .        .        .        .
     22.0  25600.9    -53.5    -70.7     34.0      3.0
     20.0  26211.8    -54.9    -71.8    343.0      1.0
     16.5  27436.4    -56.5    -73.1    315.0      8.0
     15.0  28042.8    -55.2    -72.1    330.0     11.0
     13.0  28960.1    -53.2    -70.4  -9999.0  -9999.0
76020107   3879          60
    979.3    174.0       .6     -1.5    220.0      5.0
    968.0    267.5      2.4     -3.1    250.0      7.0
    950.0    419.2      2.5     -3.0    272.0     11.0
    948.0    436.2      2.6     -3.1    274.0     12.0
    900.0    854.3      -.3     -2.7    299.0     14.0
    898.0    872.1      -.5     -2.7    299.0     14.0
    850.0   1310.2     -1.8     -4.5    300.0     16.0
    814.0   1653.1     -4.3     -5.3    301.0     17.0
    800.0   1789.7     -5.1     -6.0    298.0     18.0
    750.0   2294.4     -7.8     -8.7    295.0     18.0
```

Figure 5.11. Sample of output file from QA-UPPR. R.T. = record type; refer to Table C.4 in Appendix C for more information.

REDUCE

The next program in the radiosonde pathway reduces the number of levels in each report. The user specifies on the input card image (Table 4.6, Section 4) the height above which report levels are to be discarded for all reports. The user has the option of first making all heights above ground level before discarding data. Figure 5.12 illustrates the runstream for this program.

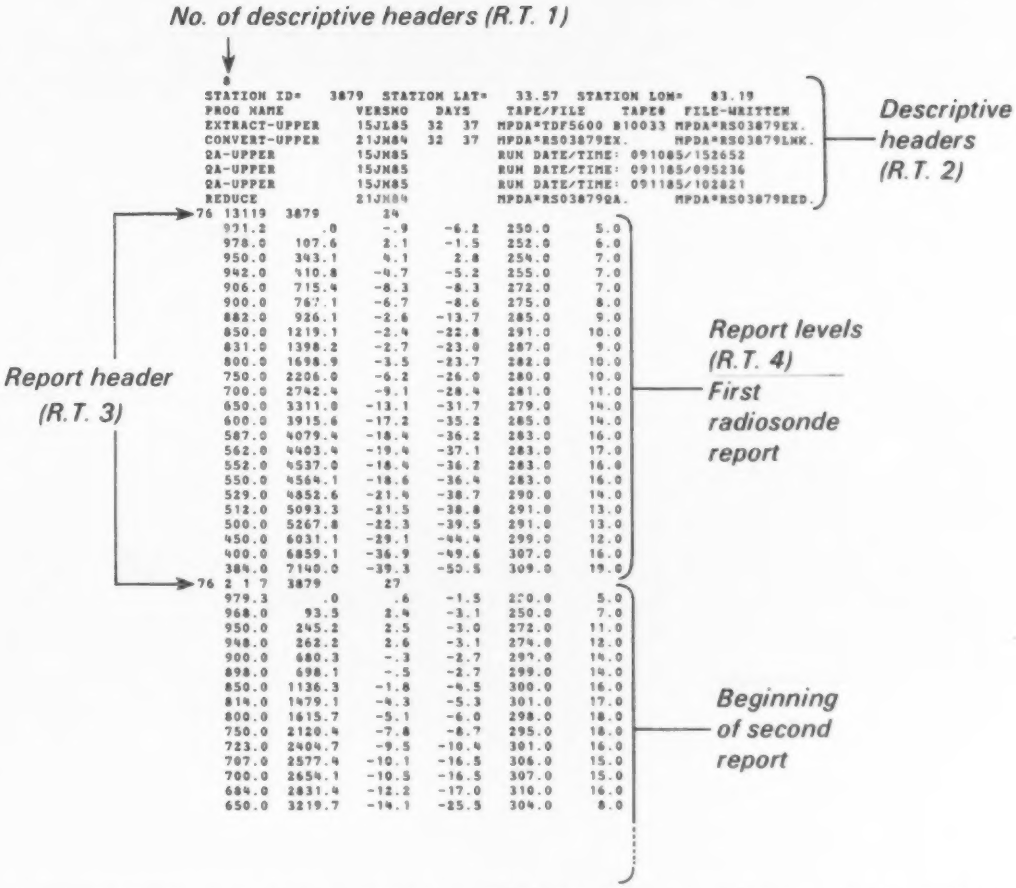


```
@RUN.R/R RUN I.D., ETC...
@ASG.A MPDA*RS03879QA.
@USE 10,MPDA*RS03879QA.
@ASG.A MPDA*RS03879RED.
@USE 11,MPDA*RS03879RED.
@XQT MPDA*MPDAPRE.REDUCE
7000.00,.TRUE.
```

input file
output file
input card image
maximum height (in meters) for all radiosonde reports
convert above sea level to above ground level

Figure 5.12. Runstream for REDUCE.

The logical file numbers 10 and 11 are used for the input (MPDA*RS03879HRLY.) and output (MPDA*RS03879RED.) files, respectively. An annotated sample of the output file is shown in Figure 5.13.

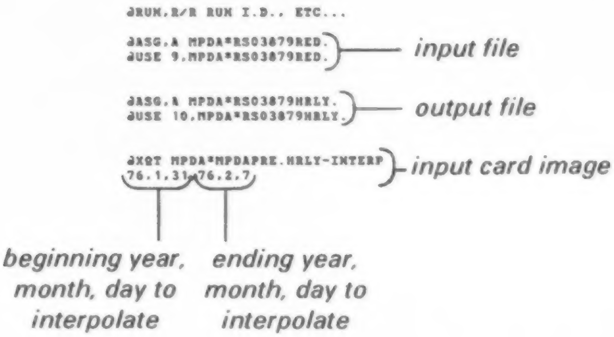

No. of descriptive headers (R.T. 1)
Descriptive headers (R.T. 2)
Report header (R.T. 3)
Report levels (R.T. 4)
First radiosonde report
Beginning of second report

```
8
STATION ID=   3879  STATION LAT=   33.57  STATION LON=   83.19
PROG NAME          VERSNO   DAYS    TAPE/FILE     TAPE#  FILE-WRITTEN
EXTRACT-UPPER      15JL85   32   37  MPDA*TDF5600 B10033 MPDA*RS03879EX.
CONVERT-UPPER      21JN84   32   37  MPDA*RS03879EX.     MPDA*RS03879LNK.
QA-UPPER           15JN85            RUN DATE/TIME: 091085/152652
QA-UPPER           15JN85            RUN DATE/TIME: 091185/095236
QA-UPPER           15JN85            RUN DATE/TIME: 091185/102821
REDUCE             21JN84            MPDA*RS03879QA.     MPDA*RS03879RED.
76 13119  3879         24
   991.2        .0      -.9     -6.2   250.0      5.0
   978.0     107.6      2.1     -1.5   252.0      6.0
   950.0     343.1      4.1      2.8   254.0      7.0
   942.0     410.8     -4.7     -5.2   255.0      7.0
   906.0     715.4     -8.3     -8.3   272.0      7.0
   900.0     767.1     -6.7     -8.6   275.0      8.0
   882.0     926.1     -2.6    -13.7   285.0      9.0
   850.0    1219.1     -2.4    -22.8   291.0     10.0
   831.0    1398.2     -2.7    -23.0   287.0      9.0
   800.0    1698.9     -3.5    -23.7   282.0     10.0
   750.0    2206.0     -6.2    -26.0   280.0     10.0
   700.0    2742.4     -9.1    -28.4   281.0     11.0
   650.0    3311.0    -13.1    -31.7   279.0     14.0
   600.0    3915.6    -17.2    -35.2   285.0     14.0
   587.0    4079.4    -18.4    -36.2   283.0     16.0
   562.0    4403.4    -19.4    -37.1   283.0     17.0
   552.0    4537.0    -18.4    -36.2   283.0     16.0
   550.0    4564.1    -18.6    -36.4   283.0     16.0
   529.0    4852.6    -21.4    -38.7   290.0     14.0
   512.0    5093.3    -21.5    -38.8   291.0     13.0
   500.0    5267.8    -22.3    -39.5   291.0     13.0
   450.0    6031.1    -29.1    -44.4   299.0     12.0
   400.0    6859.1    -36.9    -49.6   307.0     16.0
   384.0    7140.0    -39.3    -50.5   309.0     19.0
76 2 1 7  3879         27
   979.3        .0       .6     -1.5   230.0      5.0
   968.0      93.5      2.4     -3.1   250.0      7.0
   950.0     245.2      2.5     -3.0   272.0     11.0
   948.0     262.2      2.6     -3.1   274.0     12.0
   900.0     680.3      -.3     -2.7   297.0     14.0
   898.0     698.1      -.5     -2.7   299.0     14.0
   850.0    1136.3     -1.8     -4.5   300.0     16.0
   814.0    1479.1     -4.3     -5.3   301.0     17.0
   800.0    1615.7     -5.1     -6.0   298.0     18.0
   750.0    2120.4     -7.8     -8.7   295.0     18.0
   723.0    2404.7     -9.5    -10.4   301.0     16.0
   707.0    2577.4    -10.1    -16.5   306.0     15.0
   700.0    2654.1    -10.5    -16.5   307.0     15.0
   684.0    2831.4    -12.2    -17.0   310.0     16.0
   650.0    3219.7    -14.1    -25.5   304.0      8.0
```

Figure 5.13. Sample of output file from REDUCE. R.T. = record type; refer to Table C.5 in Appendix C for more information.

HRLY-INTERP

The final program in the radiosonde pathway interpolates the twice-daily radiosonde reports to hourly reports. Logical file numbers 9 and 10 are used for the input (MPDA*RS03879QA.) and output (MPDA*RS03879HRLY.) files. The input card image (Table 4.7, Section 4) consists of two pairs of dates: the beginning year, month, and day and the ending year, month, and day to interpolate. The runstream is given in Figure 5.14.



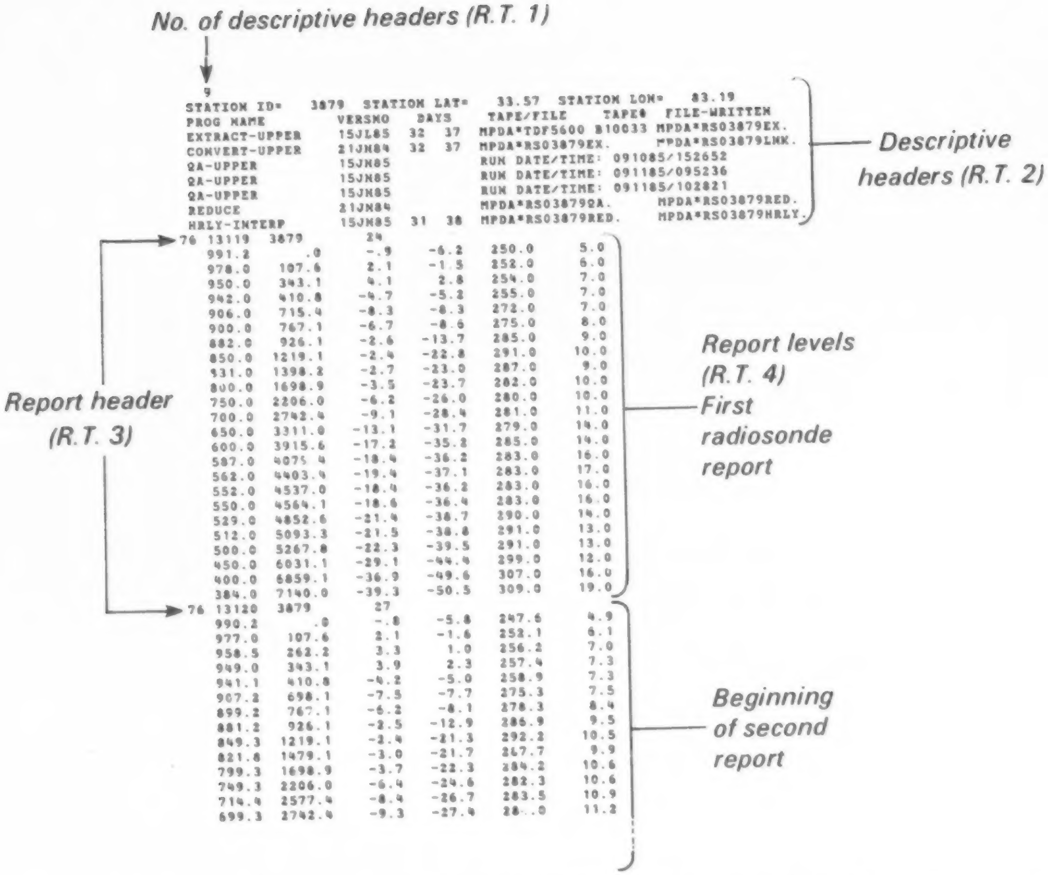
```
@RUN,R/R RUN I.D., ETC...
@ASG,A MPDA*RS03879RED.
@USE 9,MPDA*RS03879RED.
@ASG,A MPDA*RS03879HRLY.
@USE 10,MPDA*RS03879HRLY.
@XQT MPDA*MPDAPRE.HRLY-INTERP
76,1,31,76,2,7
```

input file
output file
input card image
beginning year, month, day to interpolate
ending year, month, day to interpolate

Figure 5.14. Runstream for HRLY-INTERP. Table 4.7 in Section 4 describes the input card image.

CAUTION: Because the frequency of reports increases from 2 to 24, the number of lines in the output file increases substantially. The output file for one month of data consists of about 20,000 lines of data.

An annotated sample of the output file is shown in Figure 5.15.



No. of descriptive headers (R.T. 1)

```
9
STATION ID=    3879  STATION LAT=    33.57  STATION LON=    83.19
PROG NAME            VERSNO    DAYS     TAPE/FILE     TAPE#   FILE-WRITTEN
EXTRACT-UPPER        15JL85   32   37   MPDA*TDF5600 B10033 MPDA*RS03879EX.
CONVERT-UPPER        21JN84   32   37   MPDA*RS03879EX.      MPDA*RS03879LNK.
QA-UPPER             15JN85             RUN DATE/TIME: 091085/152652
QA-UPPER             15JN85             RUN DATE/TIME: 091185/095236
QA-UPPER             15JN85             RUN DATE/TIME: 091185/102821
REDUCE               21JN84             MPDA*RS03879QA.      MPDA*RS03879RED.
HRLY-INTERP          15JN85   31   38   MPDA*RS03879RED.     MPDA*RS03879HRLY.
76 13119  3879           24
    991.2        .0      -.9      -6.2    250.0      5.0
    978.0     107.6      2.1      -1.5    252.0      6.0
    950.0     343.1      4.1       2.8    254.0      7.0
    942.0     410.8     -4.7      -5.2    255.0      7.0
    906.0     715.4     -8.3      -8.3    272.0      7.0
    900.0     767.1     -6.7      -8.6    275.0      8.0
    882.0     926.1     -2.6     -13.7    285.0      9.0
    850.0    1219.1     -2.4     -22.8    291.0     10.0
    831.0    1398.2     -2.7     -23.0    287.0      9.0
    800.0    1698.9     -3.5     -23.7    282.0     10.0
    750.0    2206.0     -6.2     -26.0    280.0     10.0
    700.0    2742.4     -9.1     -28.4    281.0     11.0
    650.0    3311.0    -13.1     -31.7    279.0     14.0
    600.0    3915.6    -17.2     -35.2    285.0     14.0
    587.0    4075.4    -18.4     -36.2    283.0     16.0
    562.0    4403.4    -19.4     -37.1    283.0     17.0
    552.0    4537.0    -18.4     -36.2    283.0     16.0
    550.0    4564.1    -18.6     -36.4    283.0     16.0
    529.0    4852.6    -21.4     -38.7    290.0     14.0
    512.0    5093.3    -21.5     -38.8    291.0     13.0
    500.0    5267.8    -22.3     -39.5    291.0     13.0
    450.0    6031.1    -29.1     -44.4    299.0     12.0
    400.0    6859.1    -36.9     -49.6    307.0     16.0
    384.0    7140.0    -39.3     -50.5    309.0     19.0
76 13120  3879           27
    990.2        .0      -.8      -5.8    247.6      4.9
    977.0     107.6      2.1      -1.6    252.1      6.1
    958.5     262.2      3.3       1.0    256.2      7.0
    949.0     343.1      3.9       2.3    257.4      7.3
    941.1     410.8     -4.2      -5.0    258.9      7.3
    907.2     698.1     -7.5      -7.7    275.3      7.5
    899.2     767.1     -6.2      -8.1    278.3      8.4
    881.2     926.1     -2.5     -12.9    286.9      9.5
    849.3    1219.1     -2.4     -21.3    292.2     10.5
    821.8    1479.1     -3.0     -21.7    287.7      9.9
    799.3    1698.9     -3.7     -22.3    284.2     10.6
    749.3    2206.0     -6.4     -24.6    282.3     10.6
    714.4    2577.4     -8.4     -26.7    283.5     10.9
    699.3    2742.4     -9.3     -27.4    28..0     11.2
```

Descriptive headers (R.T. 2)

Report header (R.T. 3)

Report levels (R.T. 4)

First radiosonde report

Beginning of second report

Figure 5.15. Sample of output file from HRLY-INTERP. R.T. = record type; refer to Table C.8 in Appendix C for more information.

SURFACE OBSERVATION DATA PATHWAY

Figure 5.16 illustrates the surface observation data pathway using the program and data file names from this sample problem.

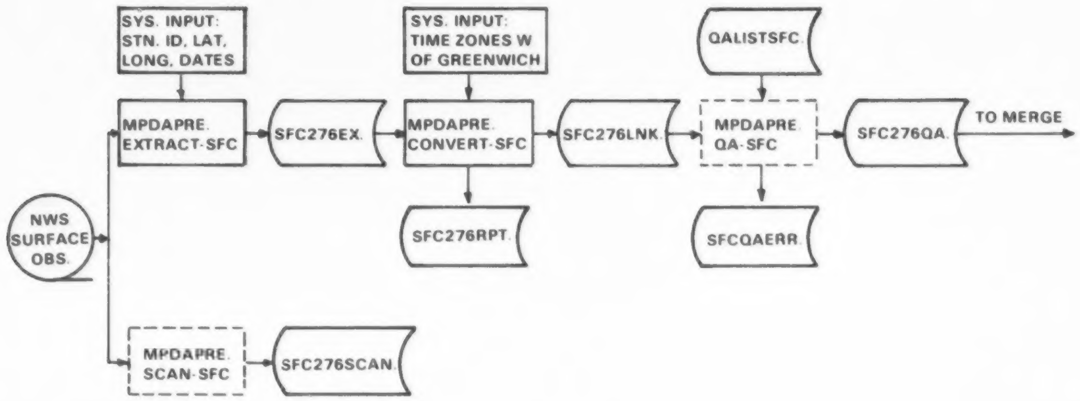

SYS. INPUT: STN. ID, LAT, LONG, DATES
SYS. INPUT: TIME ZONES W OF GREENWICH
QALISTSFC.
MPDAPRE. EXTRACT-SFC
SFC276EX.
MPDAPRE. CONVERT-SFC
SFC276LNK.
MPDAPRE. QA-SFC
SFC276QA.
TO MERGE
NWS SURFACE OBS.
SFC276RPT.
SFCQAERR.
MPDAPRE. SCAN-SFC
SFC276SCAN.

Figure 5.16. The surface observation data pathway. Program and data file names are from the sample problem.

SCAN-SFC

The magnetic tape is attached to the name SFCOB for use by ATAPE and to logical file 10 to retrieve the tape name associated with the @ASG statement. Logical file 8 is used for the output (MPDA*SFC276SCAN.) file. The tape is moved past five EOF marks to scan the correct file. The runstream for the program is shown in Figure 5.17.

```
@RUN.R/R RUN I.D., ETC...

@ASG.A MPDA*SFC276SCAN.
@USE 8.MPDA*SFC276SCAN.

@ASG.TJ/R MPDA*WRBANSO.,U9S//////Q.B10033
@USE SFCOB.,MPDA*WRBANSO.
@USE 10.SFCOB.
@REWIND SFCOB.
@MOVE SFCOB.,5

@XQT MPDA*MPDAPRE.SCAN-SFC
'EBCD'
```

output file - report of stations and dates

input tape

option to convert EBCDIC to ASCII character format

Figure 5.17. Runstream for SCAN-SFC. Table 4.8 in Section 4 describes the input card image.

Table 4.8 in Section 4 describes the input card image. An example of the output from the scanning program is shown in Figure 5.18.

```
                    **WBAN ASHEVILLE SURFACE OBSERVATION TAPE SUMMARY**

TAPENAME=MPDA*WRBANSO.          TAPE NUMBER=

START STAT ID YEAR MONTH DAY HOUR JULIAN DATE  END STAT ID YEAR MONTH DAY HOUR JULIAN DATE
      03820   74       1  31   0       31            03820     75   1  31   0      31
      03820   75       1  31   1       31            03820     76   1  31   0      31
      03820   76       1  31   1       31            03820     77   1  31   6      31
```

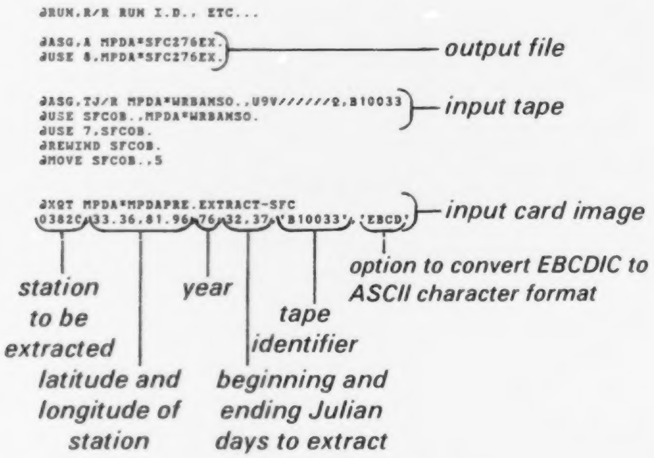
The data begin with...

and change at...

Figure 5.18. Report from SCAN-SFC.

EXTRACT-SFC

The magnetic tape is attached to the name SFCOB for use by ATAPE and to logical file 10 to retrieve the tape name associated with the @ASG statement. Logical file number 8 is used for the output (MPDA*SFC276EX.) file. The tape is moved past five EOF marks to read the correct data file. The runstream is illustrated in Figure 5.19. The input card image, described in Table 4.9 of Section 4, requires a station identifier, station latitude and longitude, year, beginning and ending Julian day, and tape identifier. The data for February 1, 1976 through February 5, 1976 (Julian days 32 through 37) are extracted for the sample problem.

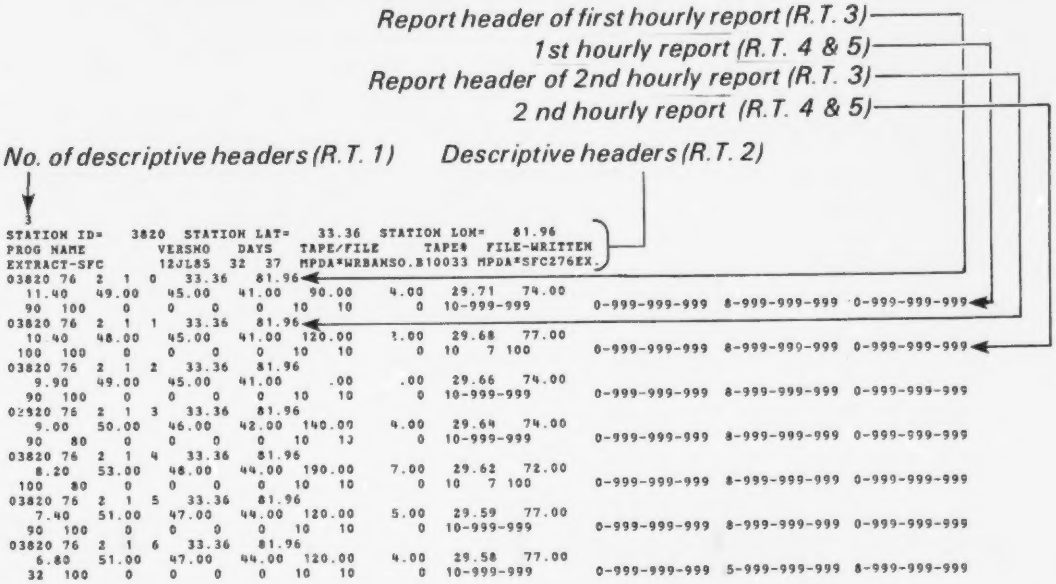


```
@RUN,R/R RUN I.D., ETC...

@ASG,A MPDA*SFC276EX.
@USE 8.MPDA*SFC276EX.

@ASG,TJ/R MPDA*WRBAMSO.,U9V///////2,B10033
@USE SFCOB.,MPDA*WRBAMSO.
@USE 7.SFCOB.
@REWIND SFCOB.
@MOVE SFCOB.,5

@XQT MPDA*MPDAPRE.EXTRACT-SFC
0382C,33.36,81.96,76,32,37,'B10033','EBCD'
```

output file
input tape
input card image
option to convert EBCDIC to ASCII character format
station to be extracted
year
tape identifier
latitude and longitude of station
beginning and ending Julian days to extract

Figure 5.19. Runstream for EXTRACT-SFC. Table 4.9 in Section 4 describes the input card image.

An annotated sample of the output file is shown in Figure 5.20. The file contains approximately 1450 lines.

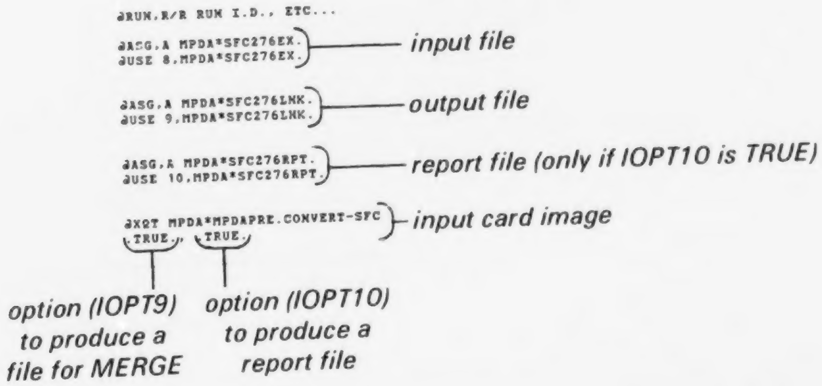

Report header of first hourly report (R.T. 3)
1st hourly report (R.T. 4 & 5)
Report header of 2nd hourly report (R.T. 3)
2 nd hourly report (R.T. 4 & 5)
No. of descriptive headers (R.T. 1)
Descriptive headers (R.T. 2)

```
3
STATION ID=    3820  STATION LAT=    33.36  STATION LON=    81.96
PROG NAME            VERSNO   DAYS   TAPE/FILE      TAPE#  FILE-WRITTEN
EXTRACT-SFC          12JL85  32  37  MPDA*WRBANSO.B10033 MPDA*SFC276EX.
03820 76  2  1  0   33.36    81.96
  11.40   49.00   45.00   41.00   90.00     4.00   29.71   74.00
  90  100    0     0    0    0   10   10        0  10-999-999      0-999-999-999  8-999-999-999  0-999-999-999
03820 76  2  1  1   33.36    81.96
  10.40   48.00   45.00   41.00  120.00     3.00   29.68   77.00
 100  100    0     0    0    0   10   10        0  10   7 100      0-999-999-999  8-999-999-999  0-999-999-999
03820 76  2  1  2   33.36    81.96
   9.90   49.00   45.00   41.00     .00      .00   29.66   74.00
  90  100    0     0    0    0   10   10        0  10-999-999      0-999-999-999  8-999-999-999  0-999-999-999
03820 76  2  1  3   33.36    81.96
   9.00   50.00   46.00   42.00  140.00     4.00   29.64   74.00
  90   80    0     0    0    0   10   10        0  10-999-999      0-999-999-999  8-999-999-999  0-999-999-999
03820 76  2  1  4   33.36    81.96
   8.20   53.00   48.00   44.00  190.00     7.00   29.62   72.00
 100   80    0     0    0    0   10   10        0  10   7 100      0-999-999-999  8-999-999-999  0-999-999-999
03820 76  2  1  5   33.36    81.96
   7.40   51.00   47.00   44.00  120.00     5.00   29.59   77.00
  90  100    0     0    0    0   10   10        0  10-999-999      0-999-999-999  8-999-999-999  0-999-999-999
03820 76  2  1  6   33.36    81.96
   6.80   51.00   47.00   44.00  120.00     4.00   29.58   77.00
  32  100    0     0    0    0   10   10        0  10-999-999      0-999-999-999  5-999-999-999  8-999-999-999
```

Figure 5.20. Sample of output file from EXTRACT-SFC. R.T. = record type; refer to Table C.6 in Appendix C for more information.

CONVERT-SFC

Logical file number 8 is used for the input file (MPDA*SFC276EX.), and numbers 9 and 10 are used for the output files (MPDA*SFC276LNK. and MPDA*SFC276RPT., respectively). The former is used by QA-SFC, whereas the latter is a report file containing headers and data for inspection by the user. The input card image (Table 4.10, Section 4) consists of two logical options to control the writing of the two output files. The runstream is illustrated in Figure 5.21.

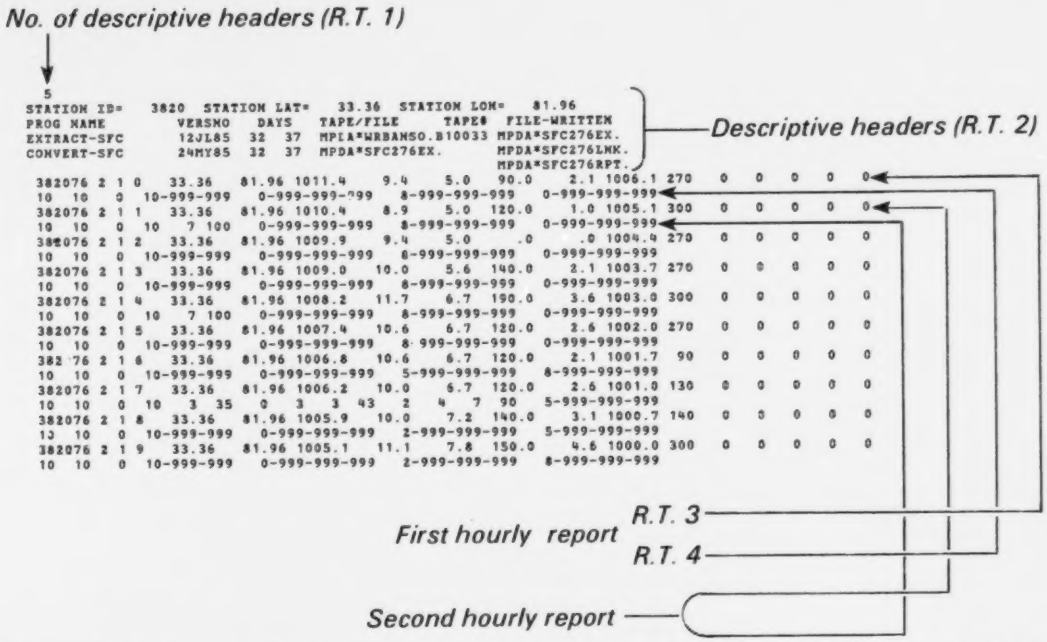


```
@RUN,R/R RUN I.D., ETC...
@ASG,A MPDA*SFC276EX.
@USE 8,MPDA*SFC276EX.
@ASG,A MPDA*SFC276LNK.
@USE 9,MPDA*SFC276LNK.
@ASG,A MPDA*SFC276RPT.
@USE 10,MPDA*SFC276RPT.
@XQT MPDA*MPDAPRE.CONVERT-SFC
.TRUE.,.TRUE.
```

input file
output file
report file (only if IOPT10 is TRUE)
input card image
option (IOPT9) to produce a file for MERGE
option (IOPT10) to produce a report file

Figure 5.21. Runstream for CONVERT-SFC. Table 4.10 in Section 4 describes the input card image.

Annotated samples of the two output files are shown in Figures 5.22 and 5.23. The file to be used by QA-SFC (Figure 5.22) contains about 1450 lines, whereas the report file (Figure 5.23) contains about 8000 lines.


No. of descriptive headers (R.T. 1)
Descriptive headers (R.T. 2)
R.T. 3
First hourly report
R.T. 4
Second hourly report

```
 5
STATION ID=   3820  STATION LAT=   33.36  STATION LON=   81.96
PROG NAME         VERSNO   DAYS   TAPE/FILE      TAPE#  FILE-WRITTEN
EXTRACT-SFC       12JL85   32  37  MPIA*WRBANSO.B10033 MPDA*SFC276EX.
CONVERT-SFC       24MY85   32  37  MPDA*SFC276EX.       MPDA*SFC276LNK.
                                                        MPDA*SFC276RPT.
 382076 2 1 0   33.36   81.96 1011.4    9.4    5.0   90.0    2.1 1006.1 270   0   0   0   0   0
 10  10   0  10-999-999   0-999-999-999   8-999-999-999   0-999-999-999
 382076 2 1 1   33.36   81.96 1010.4    8.9    5.0  120.0    1.0 1005.1 300   0   0   0   0   0
 10  10   0  10   7 100   0-999-999-999   8-999-999-999   0-999-999-999
 382076 2 1 2   33.36   81.96 1009.9    9.4    5.0     .0     .0 1004.4 270   0   0   0   0   0
 10  10   0  10-999-999   0-999-999-999   8-999-999-999   0-999-999-999
 382076 2 1 3   33.36   81.96 1009.0   10.0    5.6  140.0    2.1 1003.7 270   0   0   0   0   0
 10  10   0  10-999-999   0-999-999-999   8-999-999-999   0-999-999-999
 382076 2 1 4   33.36   81.96 1008.2   11.7    6.7  190.0    3.6 1003.0 300   0   0   0   0   0
 10  10   0  10   7 100   0-999-999-999   8-999-999-999   0-999-999-999
 382076 2 1 5   33.36   81.96 1007.4   10.6    6.7  120.0    2.6 1002.0 270   0   0   0   0   0
 10  10   0  10-999-999   0-999-999-999   8-999-999-999   0-999-999-999
 382 76 2 1 6   33.36   81.96 1006.8   10.6    6.7  120.0    2.1 1001.7  90   0   0   0   0   0
 10  10   0  10-999-999   0-999-999-999   5-999-999-999   8-999-999-999
 382076 2 1 7   33.36   81.96 1006.2   10.0    6.7  120.0    2.6 1001.0 130   0   0   0   0   0
 10  10   0  10   3  35   0   3   3  43   2   4   7  90   5-999-999-999
 382076 2 1 8   33.36   81.96 1005.9   10.0    7.2  140.0    3.1 1000.7 140   0   0   0   0   0
 10  10   0  10-999-999   0-999-999-999   2-999-999-999   5-999-999-999
 382076 2 1 9   33.36   81.96 1005.1   11.1    7.8  150.0    4.6 1000.0 300   0   0   0   0   0
 10  10   0  10-999-999   0-999-999-999   2-999-999-999   8-999-999-999
```

Figure 5.22. Sample of output file from CONVERT-SFC. R.T. = record type; refer to Table C.7 in Appendix C for more information.

```
  5
STATION ID=   3820  STATION LAT=   33.36  STATION LON=   81.96
PROG NAME          VERSNO   DAYS   TAPE/FILE      TAPE#  FILE-WRITTEN
EXTRACT-SFC        12JL85  32  37  MPDA*WRBANSO.B10033 MPDA*SFC276EX.
CONVERT-SFC        24MY85  32  37  MPDA*SFC276EX.      MPDA*SFC276LNK.
                                                       MPDA*SFC276RPT.

STATION ID  YEAR  MONTH  DAY  HOUR    STATION LAT    STATION LON
  03820       76   2       1    0            33.36       81.96
 PRESSURE     TEMP     DEWPT     WDIR    WND SPD STATION PRES
  1011.4       9.4       5.0     90.0       2.1   1006.1
CEILING HEIGHT  VISIBILITY  SEVERE WEATHER CODE  LIQ.PRECIP  FROZ.PRECIP  OBSTR TO VISION
      270        0                 0                0             0          0
   TOTAL CLDS     OPAQUE COND
        10             10
   1ST LAYER        2ND LAYER        3RD LAYER        4TH LAYER
    0  10-999-999   0-999-999-999   8-999-999-999   0-999-999-999

STATION ID  YEAR  MONTH  DAY  HOUR    STATION LAT    STATION LON
  03820       76   2       1    1            33.36       81.96
 PRESSURE     TEMP     DEWPT     WDIR    WND SPD STATION PRES
  1010.4       8.9       5.0    120.0       1.0   1005.1
CEILING HEIGHT  VISIBILITY  SEVERE WEATHER CODE  LIQ.PRECIP  FROZ.PRECIP  OBSTR TO VISION
      300        0                 0                0             0          0
   TOTAL CLDS     OPAQUE COND
        10             10
   1ST LAYER        2ND LAYER        3RD LAYER        4TH LAYER
    0  10    7 100   0-999-999-999   8-999-999-999   0-999-999-999

STATION ID  YEAR  MONTH  DAY  HOUR    STATION LAT    STATION LON
  03820       76   2       1    2            33.36       81.96
 PRESSURE     TEMP     DEWPT     WDIR    WND SPD STATION PRES
  1009.9       9.4       5.0       .0        .0   1004.4
CEILING HEIGHT  VISIBILITY  SEVERE WEATHER CODE  LIQ.PRECIP  FROZ.PRECIP  OBSTR TO VISION
      270        0                 0                0             0          0
   TOTAL CLDS     OPAQUE COND
        10             10
   1ST LAYER        2ND LAYER        3RD LAYER        4TH LAYER
    0  10-999-999   0-999-999-999   8-999-999-999   0-999-999-999

STATION ID  YEAR  MONTH  DAY  HOUR    STATION LAT    STATION LON
  03820       76   2       1    3            33.36       81.96
 PRESSURE     TEMP     DEWPT     WDIR    WND SPD STATION PRES
  1009.0      10.0       5.6    140.0       2.1   1003.7
CEILING HEIGHT  VISIBILITY  SEVERE WEATHER CODE  LIQ.PRECIP  FROZ.PRECIP  OBSTR TO VISION
      270        0                 0                0             0          0
   TOTAL CLDS     OPAQUE COND
        10             10
   1ST LAYER        2ND LAYER        3RD LAYER        4TH LAYER
    0  10-999-999   0-999-999-999   8-999-999-999   0-999-999-999
```

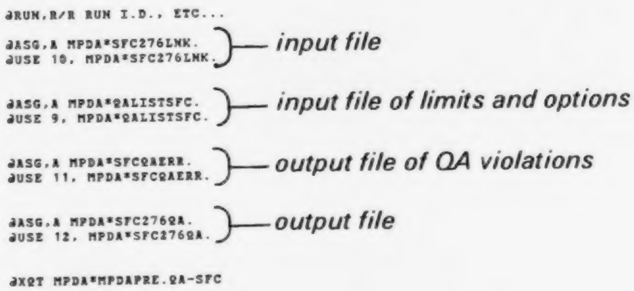
First hourly report

Second hourly report

Figure 5.23. Sample of the report file for CONVERT-SFC.

QA-SFC

A more detailed description of this program appears in Section 6. QA-SFC requires primary and secondary input and output files. The primary input file (MPDA*SFC276LNK.) is attached to logical file 10, and the primary output file (MPDA*SFC276QA.) is attached to logical file 12. The runstream is illustrated in Figure 5.24. The list of options and limits for the evaluation (Figure 5.25) is attached to logical unit 9, and the report of violations is attached to logical file 11. The options and limits are read with a NAMELIST-directed READ. Refer to Section 7 for a more complete discussion of NAMELIST. The formats for the primary input and output files are presented in Tables C.7 and C.8 in Appendix C; the format for the file of limits and options is in Table 4.11 in Section 4.



```
@RUN,R/R RUN I.D., ETC...
@ASG,A MPDA*SFC276LNK.
@USE 10, MPDA*SFC276LNK.
@ASG,A MPDA*QALISTSFC.
@USE 9, MPDA*QALISTSFC.
@ASG,A MPDA*SFCQAERR.
@USE 11, MPDA*SFCQAERR.
@ASG,A MPDA*SFC276QA.
@USE 12, MPDA*SFC276QA.
@XQT MPDA*MPDAPRE.QA-SFC
```

input file
input file of limits and options
output file of QA violations
output file

Figure 5.24. Runstream for QA-SFC.

```
 $TESTS
   BLAT =30.0,
   TMINO =-20.0,
   TMAXO =40.0,
   DTMNDL =0.0,
   DTMXDL =0.0,
   DMINO = -12.0,
   DMAXO = 25.0,
   DDMNDL = 0.0,
   DDMXDL = 0.0,
   WSMAX = 50.0,
   WSMIN = 0.0,
   SLPMAX = 1050.0,
   SLPMIN = 950.0
$END
```

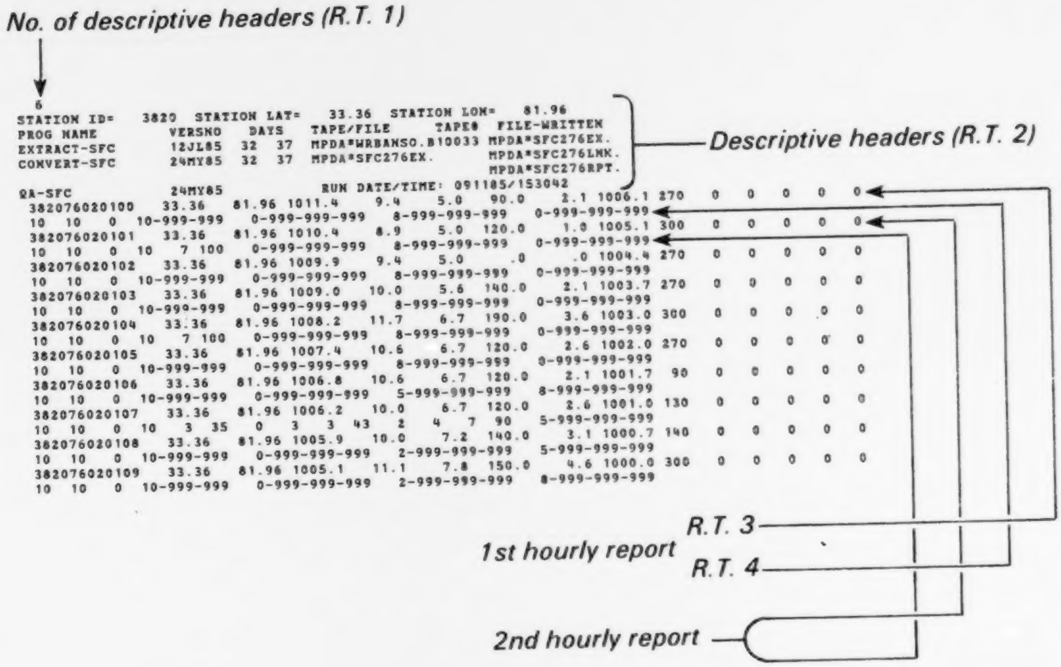
Figure 5.25. List of options and limits for QA-SFC.

When the program was executed, no violations of the criteria were detected. For convenience, the assessment criteria are printed (Figure 5.26).

```
ASSESSMENT CRITERIA
    BLAT:        30.00
    TMINO:      -20.00
    TMAXO:       40.00
    DTMNDL:        .00
    DTMXDL:        .00
    DMINO:      -12.00
    DMAXO:       25.00
    DDMNDL:        .00
    DDMXDL:        .00
    WSMIN:         .00
    WSMAX:       50.00
    SLPMIN:     950.00
    SLPMAX:    1050.00
```

Figure 5.26. QA-SFC report of violations. No violations occurred, so only assessment criteria are printed.

An annotated sample of the output file is shown in Figure 5.27.


No. of descriptive headers (R.T. 1)
Descriptive headers (R.T. 2)
R.T. 3
1st hourly report
R.T. 4
2nd hourly report

```
 6
STATION ID=   3820  STATION LAT=   33.36  STATION LON=   81.96
PROG NAME          VERSNO   DAYS   TAPE/FILE      TAPE#  FILE-WRITTEN
EXTRACT-SFC        12JL85   32  37  MPDA*WRBANSO.B10033 MPDA*SFC276EX.
CONVERT-SFC        24MY85   32  37  MPDA*SFC276EX.      MPDA*SFC276LNK.
                                                        MPDA*SFC276RPT.
QA-SFC             24MY85              RUN DATE/TIME: 091185/153042
 382076020100    33.36   81.96 1011.4    9.4    5.0   90.0     2.1 1006.1 270    0    0    0    0    0
 10   10    0  10-999-999    0-999-999-999   8-999-999-999   0-999-999-999
 382076020101    33.36   81.96 1010.4    8.9    5.0  120.0     1.0 1005.1 300    0    0    0    0    0
 10   10    0  10    7 100    0-999-999-999   8-999-999-999   0-999-999-999
 382076020102    33.36   81.96 1009.9    9.4    5.0     .0      .0 1004.4 270    0    0    0    0    0
 10   10    0  10-999-999    0-999-999-999   8-999-999-999   0-999-999-999
 382076020103    33.36   81.96 1009.0   10.0    5.6  140.0     2.1 1003.7 270    0    0    0    0    0
 10   10    0  10-999-999    0-999-999-999   8-999-999-999   0-999-999-999
 382076020104    33.36   81.96 1008.2   11.7    6.7  190.0     3.6 1003.0 300    0    0    0    0    0
 10   10    0  10    7 100    0-999-999-999   8-999-999-999   0-999-999-999
 382076020105    33.36   81.96 1007.4   10.6    6.7  120.0     2.6 1002.0 270    0    0    0    0    0
 10   10    0  10-999-999    0-999-999-999   8-999-999-999   0-999-999-999
 382076020106    33.36   81.96 1006.8   10.6    6.7  120.0     2.1 1001.7  90    0    0    0    0    0
 10   10    0  10-999-999    0-999-999-999   5-999-999-999   8-999-999-999
 382076020107    33.36   81.96 1006.2   10.0    6.7  120.0     2.6 1001.0 130    0    0    0    0    0
 10   10    0  10    3  35    0    3    3  43    2    4    7   90   5-999-999-999
 382076020108    33.36   81.96 1005.9   10.0    7.2  140.0     3.1 1000.7 140    0    0    0    0    0
 10   10    0  10-999-999    0-999-999-999   2-999-999-999   5-999-999-999
 382076020109    33.36   81.96 1005.1   11.1    7.8  150.0     4.6 1000.0 300    0    0    0    0    0
 10   10    0  10-999-999    0-999-999-999   2-999-999-999   8-999-999-999
```

Figure 5.27. Sample of output file from QA-SFC. R.T. = record type; refer to Table C.9 in Appendix C for more information.

ON-SITE DATA PATHWAY

As illustrated in Figure 5.28, the on-site data pathway of the preprocessor consists only of an optional QA program. The variability of formats for on-site data makes it impractical to provide SCAN, EXTRACT, and LINK programs for this pathway. If the on-site QA program is used, the data will be formatted according to the requirements of the MERGE program.

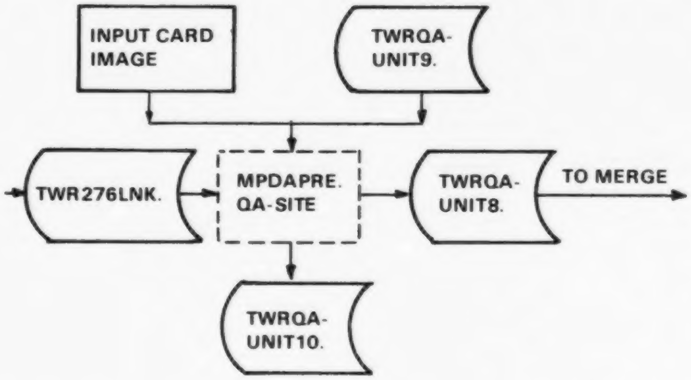
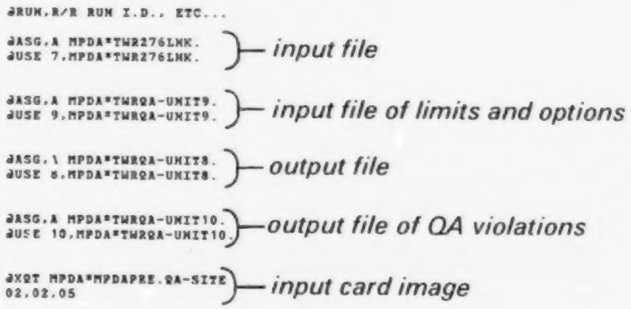

INPUT CARD IMAGE
TWRQA-UNIT9.
TWR276LNK.
MPDAPRE. QA-SITE
TWRQA-UNIT8.
TO MERGE
TWRQA-UNIT10.

Figure 5.28. The on-site data pathway. Program and data file names are from the sample problem.

QA-SITE

To execute the runstream as it is shown here, the user should retrieve the data file MPDA*TWR276LNK. from the tape and put it in a disk file. The file is the seventh file on the tape and consists of approximately 2500 lines of data in the format shown in Table 4.14. As with the previous QA programs, QA-SITE requires four input/output files. The runstream is illustrated in Figure 5.29. The data set to be evaluated (MPDA*TWR276LNK.) is attached to logical file 7, and the file of limits and options (MPDA*TWRQA-UNIT9.) used in the assessment (Figure 5.30) is attached to logical file 9. This program also requires an input card image (see Table 4.15, Section 4) that specifies the first and last months to be evaluated and the number of radiation bands in the data set.



```
@RUN,R/R RUN I.D., ETC...
@ASG,A MPDA*TWR276LNK.
@USE 7,MPDA*TWR276LNK.
@ASG,A MPDA*TWRQA-UNIT9.
@USE 9,MPDA*TWRQA-UNIT9.
@ASG,A MPDA*TWRQA-UNIT8.
@USE 8,MPDA*TWRQA-UNIT8.
@ASG,A MPDA*TWRQA-UNIT10.
@USE 10,MPDA*TWRQA-UNIT10.
@XQT MPDA*MPDAPRE.QA-SITE
02,02,05
```

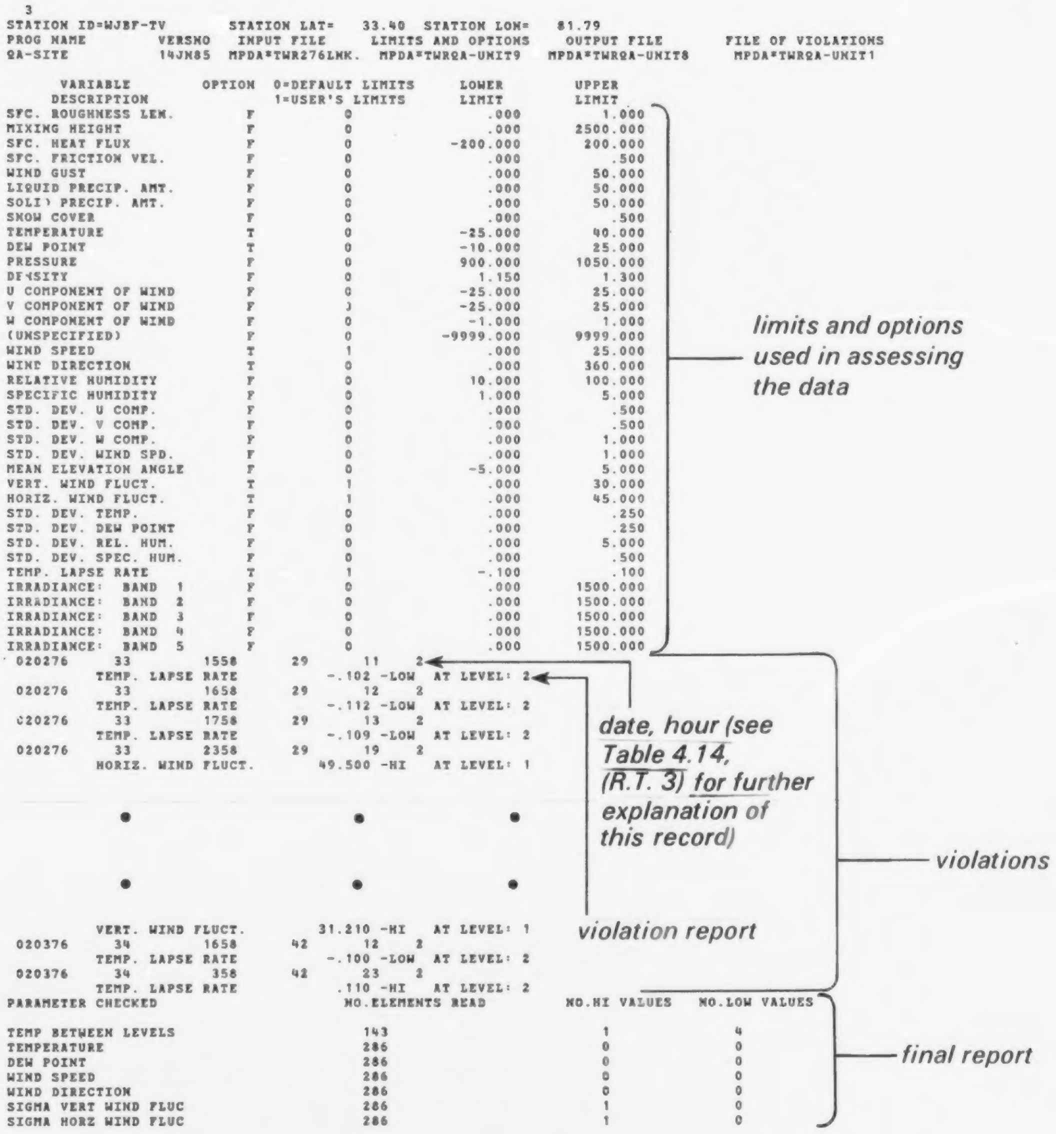
input file
input file of limits and options
output file
output file of QA violations
input card image

Figure 5.29. Runstream for QA-SITE.

```
'ZO    ',.FALSE.,0,0.0,0.0
'ZI    ',.FALSE.,0,0.0,0.0
'HO    ',.FALSE.,0,0.0,0.0
'U*    ',.FALSE.,0,0.0,0.0
'GUST  ',.FALSE.,0,0.0,0.0
'LPPT  ',.FALSE.,0,0.0,0.0
'SPPT  ',.FALSE.,0,0.0,0.0
'SNOW  ',.FALSE.,0,0.0,0.0
'TEMP  ',.TRUE.,0,0.0,0.0
'DEWPT',.TRUE.,0,0.0,0.0
'P     ',.FALSE.,0,0.0,0.0
'RHO   ',.FALSE.,0,0.0,0.0
'U     ',.FALSE.,0,0.0,0.0
'V     ',.FALSE.,0,0.0,0.0
'W     ',.FALSE.,0,0.0,0.0
'UNSPEC',.FALSE.,0,0.0,0.0
'SPEED',.TRUE.,1,0.0,25.0
'DIR   ',.TRUE.,0,0.0,0.0
'RH    ',.FALSE.,0,0.0,0.0
'SH    ',.FALSE.,0,0.0,0.0
'SIGU  ',.FALSE.,0,0.0,0.0
'SIGV  ',.FALSE.,0,0.0,0.0
'SIGW  ',.FALSE.,0,0.0,0.0
'SIGWS',.FALSE.,0,0.0,0.0
'MEA   ',.FALSE.,0,0.0,0.0
'SIGE  ',.TRUE.,1,0.0,30.0
'SIGA  ',.TRUE.,1,0.0,45.0
'SIGT  ',.FALSE.,0,0.0,0.0
'SIGDP',.FALSE.,0,0.0,0.0
'SIGRH',.FALSE.,0,0.0,0.0
'SIGSH',.FALSE.,0,0.0,0.0
'LAPSE',.TRUE.,1,-0.10,0.10
'RAD1  ',.FALSE.,0,0.0,0.0
'RAD2  ',.FALSE.,0,0.0,0.0
'RAD3  ',.FALSE.,0,0.0,0.0
'RAD4  ',.FALSE.,0,0.0,0.0
'RAD5  ',.FALSE.,0,0.0,0.0
```

Figure 5.30. List of limits and options for QA-SITE. See Table 4.12 in Section 4 for a description of this file.

The violations resulting from the evaluation are written to a file attached to logical file 10. Figure 5.31 illustrates the output report of violations. For each hour for which a violation is detected, a message indicating which variable exceeded the limits is printed. The value and whether it exceeds the upper (-HI) or lower (-LOW) limit is also printed; if it is a multilevel variable, the level at which the violation occurred is printed. A tally of violations is given at the end of the report. This example evaluates lapse rate, temperature, dew point, wind speed, wind direction, and vertical and horizontal wind fluctuations. The output file (Figure 5.32) is attached to logical file 8.



```
  3
STATION ID=WJBF-TV        STATION LAT=   33.40  STATION LON=   81.79
PROG NAME          VERSNO   INPUT FILE      LIMITS AND OPTIONS    OUTPUT FILE         FILE OF VIOLATIONS
QA-SITE            14JN85  MPDA*TWR276LNK.  MPDA*TWRQA-UNIT9   MPDA*TWRQA-UNIT8      MPDA*TWRQA-UNIT1

      VARIABLE          OPTION  0=DEFAULT LIMITS      LOWER        UPPER
     DESCRIPTION                1=USER'S LIMITS       LIMIT        LIMIT
SFC. ROUGHNESS LEN.         F           0               .000        1.000
MIXING HEIGHT               F           0               .000     2500.000
SFC. HEAT FLUX              F           0           -200.000      200.000
SFC. FRICTION VEL.          F           0               .000         .500
WIND GUST                   F           0               .000       50.000
LIQUID PRECIP. AMT.         F           0               .000       50.000
SOLID PRECIP. AMT.          F           0               .000       50.000
SNOW COVER                  F           0               .000         .500
TEMPERATURE                 T           0            -25.000       40.000
DEW POINT                   T           0            -10.000       25.000
PRESSURE                    F           0            900.000     1050.000
DENSITY                     F           0              1.150        1.300
U COMPONENT OF WIND         F           0            -25.000       25.000
V COMPONENT OF WIND         F           0            -25.000       25.000
W COMPONENT OF WIND         F           0             -1.000        1.000
(UNSPECIFIED)               F           0          -9999.000     9999.000
WIND SPEED                  T           1               .000       25.000
WIND DIRECTION              T           0               .000      360.000
RELATIVE HUMIDITY           F           0             10.000      100.000
SPECIFIC HUMIDITY           F           0              1.000        5.000
STD. DEV. U COMP.           F           0               .000         .500
STD. DEV. V COMP.           F           0               .000         .500
STD. DEV. W COMP.           F           0               .000        1.000
STD. DEV. WIND SPD.         F           0               .000        1.000
MEAN ELEVATION ANGLE        F           0             -5.000        5.000
VERT. WIND FLUCT.           T           1               .000       30.000
HORIZ. WIND FLUCT.          T           1               .000       45.000
STD. DEV. TEMP.             F           0               .000         .250
STD. DEV. DEW POINT         F           0               .000         .250
STD. DEV. REL. HUM.         F           0               .000        5.000
STD. DEV. SPEC. HUM.        F           0               .000         .500
TEMP. LAPSE RATE            T           1              -.100         .100
IRRADIANCE:  BAND  1        F           0               .000     1500.000
IRRADIANCE:  BAND  2        F           0               .000     1500.000
IRRADIANCE:  BAND  3        F           0               .000     1500.000
IRRADIANCE:  BAND  4        F           0               .000     1500.000
IRRADIANCE:  BAND  5        F           0               .000     1500.000
 020276     33          1558       29        11    2
         TEMP. LAPSE RATE              -.102 -LOW   AT LEVEL: 2
 020276     33          1658       29        12    2
         TEMP. LAPSE RATE              -.112 -LOW   AT LEVEL: 2
 020276     33          1758       29        13    2
         TEMP. LAPSE RATE              -.109 -LOW   AT LEVEL: 2
 020276     33          2358       29        19    2
         HORIZ. WIND FLUCT.           49.500 -HI    AT LEVEL: 1

           •                          •                  •

           •                          •                  •

         VERT. WIND FLUCT.            31.210 -HI    AT LEVEL: 1
 020376     34          1658       42        12    2
         TEMP. LAPSE RATE              -.100 -LOW   AT LEVEL: 2
 020376     34           358       42        23    2
         TEMP. LAPSE RATE               .110 -HI    AT LEVEL: 2
PARAMETER CHECKED                       NO.ELEMENTS READ          NO.HI VALUES    NO.LOW VALUES

TEMP BETWEEN LEVELS                          143                       1                4
TEMPERATURE                                  286                       0                0
DEW POINT                                    286                       0                0
WIND SPEED                                   286                       0                0
WIND DIRECTION                               286                       0                0
SIGMA VERT WIND FLUC                         286                       1                0
SIGMA HORZ WIND FLUC                         286                       1                0
```

limits and options used in assessing the data

date, hour (see Table 4.14, (R.T. 3) for further explanation of this record)

violations

violation report

final report

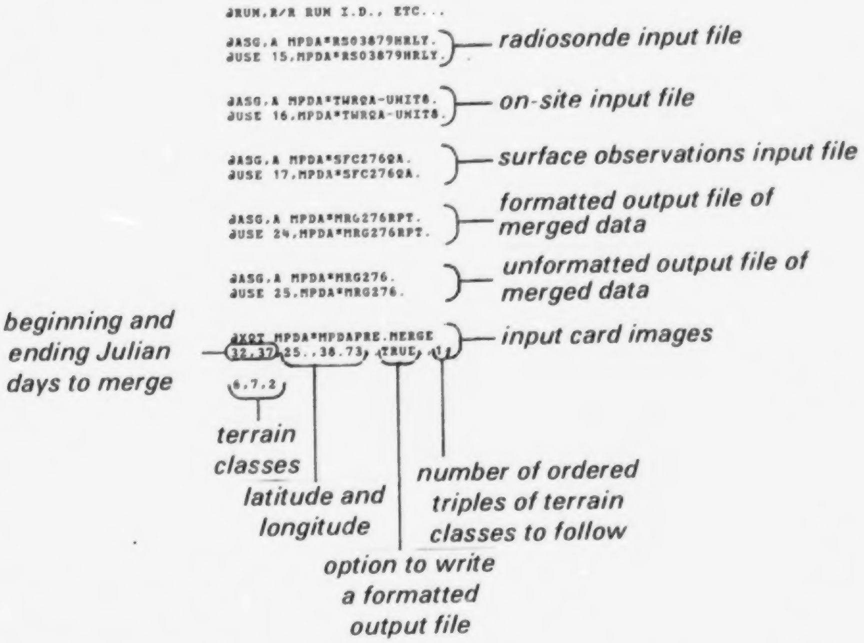
Figure 5.31. Report of violations for QA-SITE.

```
  3
STATION ID=WJBF-TV        STATION LAT=   33.40  STATION LCM=   81.79
PROG NAME          VERSNO   INPUT FILE     LIMITS AND OPTIONS    OUTPUT FILE        FILE OF VIOLATIONS
QA-SITE            14JN85  MPDA*TWR276LNK.  MPDA*TWRQA-UNIT9.  MPDA*TWRQA-UNIT8.    MPDA*TWRQA-UNIT10
  2 176      32            458        29         0    2
-9999.0 -9999.0 -9999.0 -9999.0 -9999.0 -9999.0 -9999.0 -9999 -9999
 10.0      13.05250        .10000      2.62000        .39000    164.56000      6.85000     58.64000      5.13000
 10.0  -9999.00000  -9999.00000  -9999.00000  -9999.00000  -9999.00000  -9999.00000  -9999.00000  -9999.00000
 10.0  -9999.00000  -9999.00000  -9999.00000  -9999.00000  -9999.00000  -9999.00000  -9999.00000
 10.0 5
1.000    -9999.00000
2.000    -9999.00000
3.000    -9999.00000
4.000    -9999.00000
5.000    -9999.00000
 36.0      12.75250        .10000      4.81000        .48000    168.91000      4.54000     58.86000      3.59000
 36.0  -9999.00000  -9999.00000  -9999.00000  -9999.00000  -9999.00000  -9999.00000  -9999.00000  -9999.00000
 36.0  -9999.00000  -9999.00000  -9999.00000  -9999.00000  -9999.00000  -9999.00000  -9999.00000
 36.0 5
1.000    -9999.00000
2.000    -9999.00000
3.000    -9999.00000
4.000    -9999.00000
5.000    -9999.00000
  2 176      32            558        29         1    2
-9999.0 -9999.0 -9999.0 -9999.0 -9999.0 -9999.0 -9999.0 -9999 -9999
 10.0      12.42250        .11000      2.35000        .31000    155.95000      6.68000     58.04000      4.65000
 10.0  -9999.00000  -9999.00000  -9999.00000  -9999.00000  -9999.00000  -9999.00000  -9999.00000  -9999.00000
 10.0  -9999.00000  -9999.00000  -9999.00000  -9999.00000  -9999.00000  -9999.00000  -9999.00000
 10.0 5
1.000    -9999.00000
2.000    -9999.00000
3.000    -9999.00000
4.000    -9999.00000
5.000    -9999.00000
 36.0      12.70250        .10000      4.53000        .33000    167.54000      5.30000     59.06000      3.06000
 36.0  -9999.00000  -9999.00000  -9999.00000  -9999.00000  -9999.00000  -9999.00000  -9999.00000  -9999.00000
 36.0  -9999.00000  -9999.00000  -9999.00000  -9999.00000  -9999.00000  -9999.00000  -9999.00000
 36.0 5
1.000    -9999.00000
2.000    -9999.00000
3.000    -9999.00000
4.000    -9999.00000
5.000    -9999.00000
  2 176      32            658        29         2    2
-9999.0 -9999.0 -9999.0 -9999.0 -9999.0 -9999.0 -9999.0 -9999 -9999
 10.0      12.24250        .11000      2.71000        .42000    162.84000      7.89000     57.91000      4.76000
 10.0  -9999.00000  -9999.00000  -9999.00000  -9999.00000  -9999.00000  -9999.00000  -9999.00000  -9999.00000
 10.0  -9999.00000  -9999.00000  -9999.00000  -9999.00000  -9999.00000  -9999.00000  -9999.00000
 10.0 5
1.000    -9999.00000
2.000    -9999.00000
3.000    -9999.00000
4.000    -9999.00000
5.000    -9999.00000
 36.0      11.74250        .10000      4.91000        .44000    174.81000      5.24000     59.56000      3.19000
 36.0  -9999.00000  -9999.00000  -9999.00000  -9999.00000  -9999.00000  -9999.00000  -9999.00000  -9999.00000
 36.0  -9999.00000  -9999.00000  -9999.00000  -9999.00000  -9999.00000  -9999.00000  -9999.00000
 36.0 5
1.000    -9999.00000
2.000    -9999.00000
3.000    -9999.00000
4.000    -9999.00000
5.000    -9999.00000
```

Figure 5.32. Sample of output file for QA-SITE.

MERGE

MERGE combines the output of the three data pathways into one unformatted file, which is used by the metprocessor. The radiosonde data file (MPDA*RS03879RED.) is attached to logical file 15; the surface observations data file (MPDA*SFC276QA.) is attached to logical file 17; the on-site data file (MPDA*TWR276QA.) is attached to logical file 16. The runstream for MERGE is illustrated in Figure 5.33.

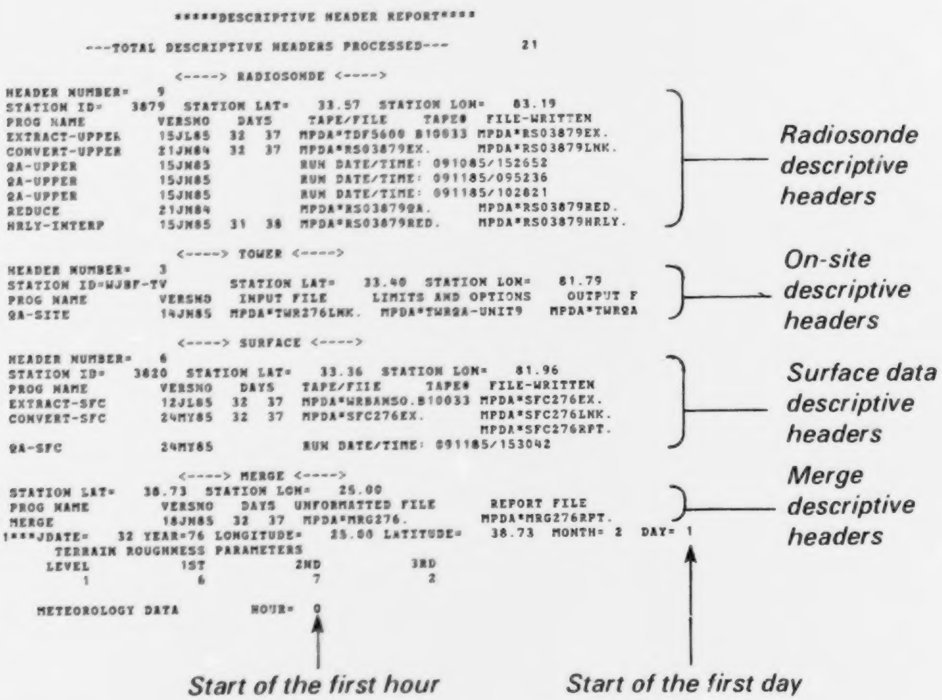


```
@RUN,R/R RUN I.D., ETC...
@ASG,A MPDA*RS03879HRLY.
@USE 15,MPDA*RS03879HRLY.
@ASG,A MPDA*TWRQA-UNIT8.
@USE 16,MPDA*TWRQA-UNIT8.
@ASG,A MPDA*SFC276QA.
@USE 17,MPDA*SFC276QA.
@ASG,A MPDA*MRG276RPT.
@USE 24,MPDA*MRG276RPT.
@ASG,A MPDA*MRG276.
@USE 25,MPDA*MRG276.
@XQT MPDA*MPDAPRE.MERGE
32,37 25.,38.73,.TRUE.,1
6,7,2
```

radiosonde input file
on-site input file
surface observations input file
formatted output file of merged data
unformatted output file of merged data
input card images
beginning and ending Julian days to merge
terrain classes
latitude and longitude
option to write a formatted output file
number of ordered triples of terrain classes to follow

Figure 5.33. Runstream for MERGE. See Table 4.16 in Section 4 for a description of the input card image.

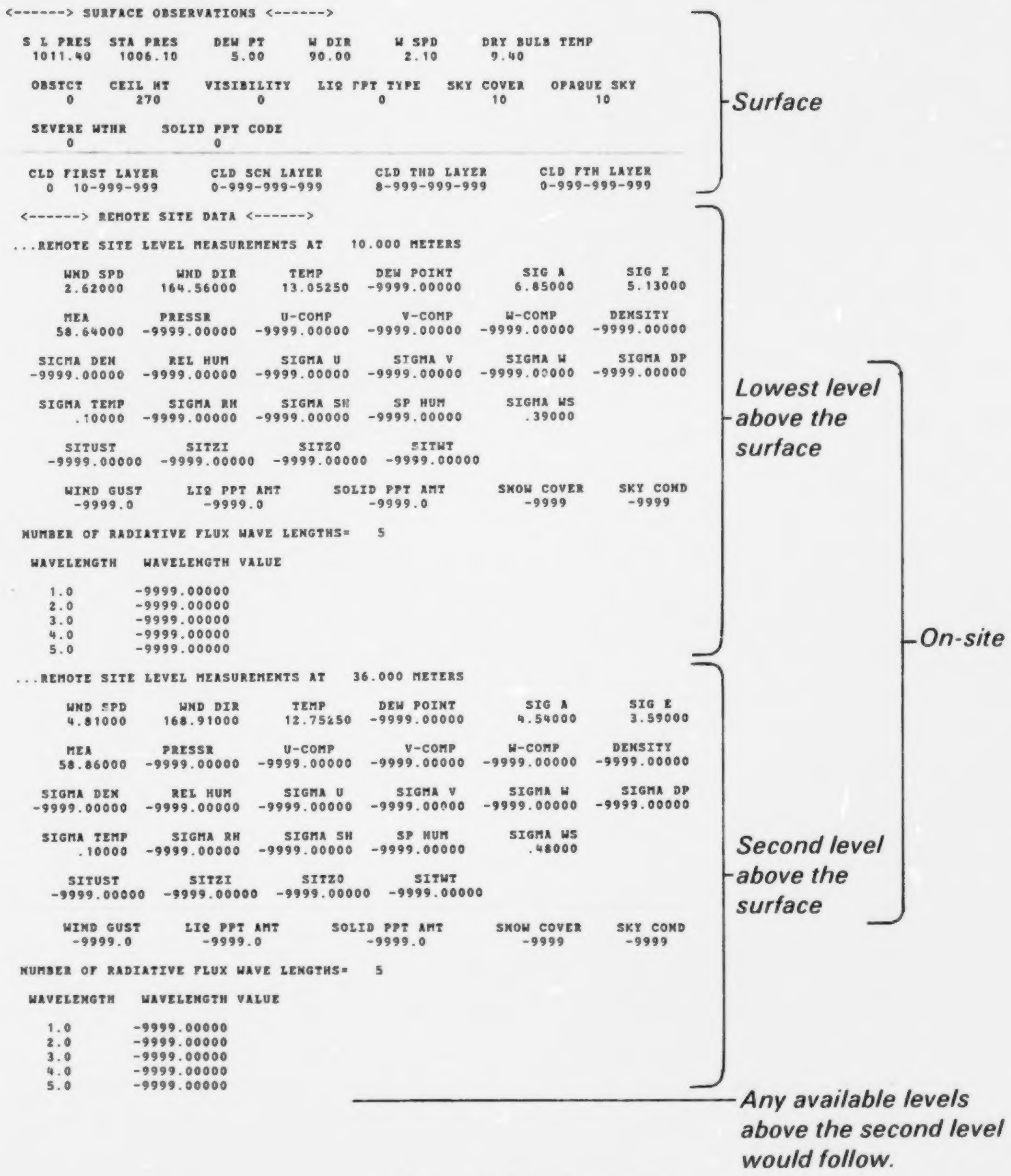
Besides the unformatted output file (MPDA*MRG276.) attached to logical file 25, the user also has the option of printing a formatted report file (MPDA*MRG276RPT.), which is attached to logical file 24. The option is specified on the input card image (see Table 4.16 in Section 4). Because MPDA*MRG276RPT. is only a report file, it is self-explanatory; therefore, no format for this file is given in the appendix. A sample of the report file is given in Figure 5.34. For one month of data, the report file produces approximately 70,000 lines.



```
                    *****DESCRIPTIVE HEADER REPORT****

            ---TOTAL DESCRIPTIVE HEADERS PROCESSED---           21

                    <----> RADIOSONDE <---->
HEADER NUMBER=   9
STATION ID=   3879  STATION LAT=   33.57  STATION LON=   83.19
PROG NAME          VERSNO   DAYS    TAPE/FILE    TAPE#  FILE-WRITTEN
EXTRACT-UPPER      15JL85  32  37  MPDA*TDF5600 810033 MPDA*RS03879EX.
CONVERT-UPPER      21JN84  32  37  MPDA*RS03879EX.      MPDA*RS03879LNK.
QA-UPPER           15JN85          RUN DATE/TIME: 091085/152652
QA-UPPER           15JN85          RUN DATE/TIME: 091185/095236
QA-UPPER           15JN85          RUN DATE/TIME: 091185/102821
REDUCE             21JN84          MPDA*RS03879QA.      MPDA*RS03879RED.
HRLY-INTERP        15JN85  31  38  MPDA*RS03879RED.     MPDA*RS03879HRLY.

                    <----> TOWER <---->
HEADER NUMBER=   3
STATION ID=WJBF-TV          STATION LAT=   33.40  STATION LON=   81.79
PROG NAME          VERSNO   INPUT FILE      LIMITS AND OPTIONS    OUTPUT F
QA-SITE            14JN85  MPDA*TWR276LNK.  MPDA*TWRQA-UNIT9   MPDA*TWRQA

                    <----> SURFACE <---->
HEADER NUMBER=   6
STATION ID=   3820  STATION LAT=   33.36  STATION LON=   81.96
PROG NAME          VERSNO   DAYS    TAPE/FIIE    TAPE#  FILE-WRITTEN
EXTRACT-SFC        12JL85  32  37  MPDA*WRBANSO.810033 MPDA*SFC276EX.
CONVERT-SFC        24MY85  32  37  MPDA*SFC276EX.      MPDA*SFC276LNK.
                                                       MPDA*SFC276RPT.
QA-SFC             24MY85          RUN DATE/TIME: 091185/153042

                    <----> MERGE <---->
STATION LAT=   38.73  STATION LON=   25.00
PROG NAME          VERSNO   DAYS  UNFORMATTED FILE      REPORT FILE
MERGE              18JN85  32  37  MPDA*MRG276.        MPDA*MRG276RPT.
1***JDATE=   32 YEAR=76 LONGITUDE=   25.00 LATITUDE=   38.73  MONTH= 2  DAY= 1
     TERRAIN ROUGHNESS PARAMETERS
    LEVEL          1ST            2ND            3RD
        1            6              7              2

   METEOROLOGY DATA        HOUR=  0
```

Radiosonde descriptive headers
On-site descriptive headers
Surface data descriptive headers
Merge descriptive headers
Start of the first hour
Start of the first day

Figure 5.34. Sample of the report file produced by MERGE. Units do not appear here, but may be found in Table C.8 for radiosonde data, C.9 for surface observation data, and Table 4.14 (Section 4) for on-site data.



```
<------> SURFACE OBSERVATIONS <------>

 S L PRES  STA PRES    DEW PT     W DIR      W SPD      DRY BULB TEMP
  1011.40   1006.10      5.00     90.00       2.10       9.40

  OBSTCT    CEIL HT    VISIBILITY   LIQ PPT TYPE   SKY COVER   OPAQUE SKY
     0        270           0             0            10          10

  SEVERE WTHR    SOLID PPT CODE
     0                0
 ------------------------------------------------------------------
  CLD FIRST LAYER       CLD SCN LAYER        CLD THD LAYER        CLD FTH LAYER
   0  10-999-999        0-999-999-999        8-999-999-999        0-999-999-999

 <------> REMOTE SITE DATA <------>

...REMOTE SITE LEVEL MEASUREMENTS AT   10.000 METERS

     WND SPD      WND DIR       TEMP      DEW POINT        SIG A        SIG E
     2.62000    164.56000    13.05250  -9999.00000      6.85000      5.13000

       MEA        PRESSR       U-COMP       V-COMP       W-COMP      DENSITY
    58.64000  -9999.00000  -9999.00000  -9999.00000  -9999.00000  -9999.00000

   SICMA DEN      REL HUM      SIGMA U      SIGMA V      SIGMA W     SIGMA DP
 -9999.00000  -9999.00000  -9999.00000  -9999.00000  -9999.00000  -9999.00000

   SIGMA TEMP    SIGMA RH     SIGMA SH      SP HUM       SIGMA WS
      .10000  -9999.00000  -9999.00000  -9999.00000       .39000

     SITUST       SITZI        SITZO        SITWT
  -9999.00000  -9999.00000  -9999.00000  -9999.00000

     WIND GUST      LIQ PPT AMT       SOLID PPT AMT       SNOW COVER    SKY COND
     -9999.0          -9999.0            -9999.0            -9999        -9999

 NUMBER OF RADIATIVE FLUX WAVE LENGTHS=   5

  WAVELENGTH   WAVELENGTH VALUE

    1.0        -9999.00000
    2.0        -9999.00000
    3.0        -9999.00000
    4.0        -9999.00000
    5.0        -9999.00000

...REMOTE SITE LEVEL MEASUREMENTS AT   36.000 METERS

     WND SPD      WND DIR       TEMP      DEW POINT        SIG A        SIG E
     4.81000    168.91000    12.75250  -9999.00000      4.54000      3.59000

       MEA        PRESSR       U-COMP       V-COMP       W-COMP      DENSITY
    58.86000  -9999.00000  -9999.00000  -9999.00000  -9999.00000  -9999.00000

   SIGMA DEN      REL HUM      SIGMA U      SIGMA V      SIGMA W     SIGMA DP
 -9999.00000  -9999.00000  -9999.00000  -9999.00000  -9999.00000  -9999.00000

   SIGMA TEMP    SIGMA RH     SIGMA SH      SP HUM       SIGMA WS
      .10000  -9999.00000  -9999.00000  -9999.00000       .48000

     SITUST       SITZI        SITZO        SITWT
  -9999.00000  -9999.00000  -9999.00000  -9999.00000

     WIND GUST      LIQ PPT AMT       SOLID PPT AMT       SNOW COVER    SKY COND
     -9999.0          -9999.0            -9999.0            -9999        -9999

 NUMBER OF RADIATIVE FLUX WAVE LENGTHS=   5

  WAVELENGTH   WAVELENGTH VALUE

    1.0        -9999.00000
    2.0        -9999.00000
    3.0        -9999.00000
    4.0        -9999.00000
    5.0        -9999.00000
```

Surface

Lowest level above the surface

Second level above the surface

On-site

Any available levels above the second level would follow.

Figure 5.34. Continued.

```
<------> RADIOSONDE DATA <------>
    LEVEL  HEIGHT       PRES        TEMP          TD       W DIR      W SPD
      1        .00     986.20        -.30       -4.20     237.60       4.80
      2     107.60     973.10        2.20       -2.20     252.50       6.50
      3     262.20     954.70        3.10        -.50     265.00       8.70
      4     343.10     945.20        3.20         .40     268.10       8.90
      5     410.80     937.30       -2.10       -4.30     271.10       9.00
      6     698.10     903.80       -4.90       -5.90     287.60       9.60
      7     767.10     896.00       -4.20       -6.30     288.60      10.40
      8     926.10     878.10       -2.00       -9.50     292.90      11.40
      9    1219.10     846.30       -2.40      -15.30     296.00      12.60
     10    1479.10     819.00       -3.50      -15.70     294.30      12.40
     11    1698.90     796.50       -4.40      -16.50     290.70      13.20
     12    2206.00     746.60       -7.10      -19.00     289.20      12.90
     13    2577.40     711.70       -9.00      -23.00     293.40      12.20
     14    2742.40     696.70      -10.00      -23.50     294.80      12.50
     15    3219.70     654.60      -13.10      -28.80     291.30      15.00
     16    3311.00     646.80      -13.80      -29.90     290.30      15.20
     17    3915.60     596.80      -18.50      -35.70     292.80      14.00
     18    4079.40     583.80      -19.60      -36.80     291.40      15.40
     19    4403.40     558.80      -21.40      -34.20     290.40      16.40
     20    4537.00     548.80      -21.30      -34.10     289.70      15.80
     21    4852.60     525.70      -23.80      -36.40     290.90      14.40
     22    5093.30     508.60      -24.70      -36.20     288.40      14.10
     23    5267.80     496.50      -25.80      -36.70     287.10      14.50
     24    5888.60     455.30      -31.20      -40.40     286.10      14.80
     25    6380.50     424.50      -35.50      -45.10     289.90      15.00
     26    6859.10     396.00      -39.50      -54.90     292.10      14.40
     27    7401.20     365.60      -43.70      -57.10     294.90      17.50
**************************************************

   METEOROLOGY DATA          HOUR=  1
<------> SURFACE OBSERVATIONS <------>

  S L PRES   STA PRES     DEW PT      W DIR      W SPD      DRY BULB TEMP
   1010.40    1005.10       5.00     120.00       1.00       8.90

  OBSTCT    CEIL HT     VISIBILITY    LIQ PPT TYPE    SKY COVER    OPAQUE SKY
```

Radiosonde

Start of the second hour

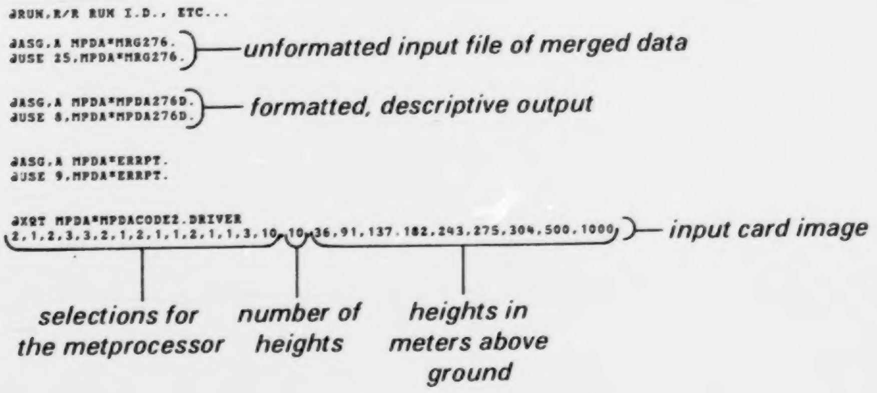
Figure 5.34. Continued.

METPROCESSOR

The metprocessor uses the merged data set (attached to logical file 25) to compute the meteorological variables. The output file, which can be formatted by one of the two subroutines provided or by the user's own subroutine, is attached to logical file 8. The input card image is described in detail in Table 4.17 of Section 4. The user can change the logical file numbers by changing the numbers in the FORTRAN PROC called INOUT (see Section 7 for more information on PROCs). In this sample problem, the following choices, as described in Table 4.17, were made:

FSELN = 2
DYBU = 1
ZOMOD = 2
HMOD = 3
USMOD = 3
LMOD = 2
ZICMOD = 1
ZIMMOD = 2
HTMOD = 1
TMPMOD = 1
UVMOD = 2
SWMOD = 1
SVMOD = 1
OUTMOD = 3

The 10 heights in the profile, in meters above the surface, were specified as follows: 10, 36, 91, 137, 182, 243, 275, 304, 500, 1000. Figure 5.35 shows the runstream for the metprocessor.

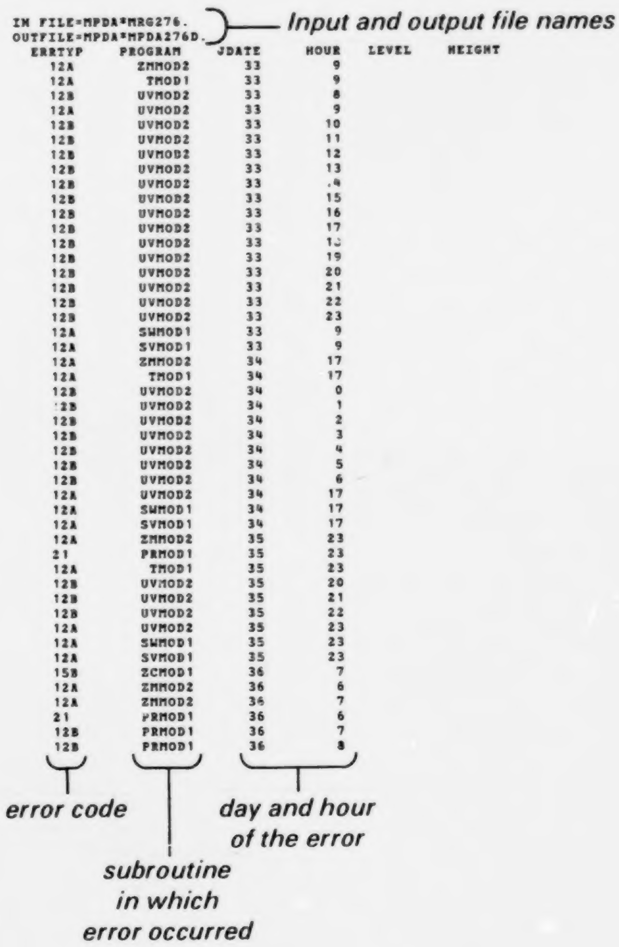


```
@RUN,R/R RUN I.D., ETC...
@ASG,A MPDA*MRG276.
@USE 25,MPDA*MRG276.
@ASG,A MPDA*MPDA276D.
@USE 8,MPDA*MPDA276D.
@ASG,A MPDA*ERRPT.
@USE 9,MPDA*ERRPT.
@XQT MPDA*MPDACODE2.DRIVER
2,1,2,3,3,2,1,2,1,1,2,1,1,3,10,10,36,91,137.182,243,275.304,500.1000
```

unformatted input file of merged data
formatted, descriptive output
input card image
selections for the metprocessor
number of heights
heights in meters above ground

Figure 5.35. Runstream for the metprocessor.

Warning messages are written whenever difficulties in the computations are encountered. Some of the messages for this sample are shown in Figure 5.36. The error codes and messages are presented in Appendix E. These are written to a file attached to logical file 9. A summary table of the errors, by subroutine, is written to the default output device.

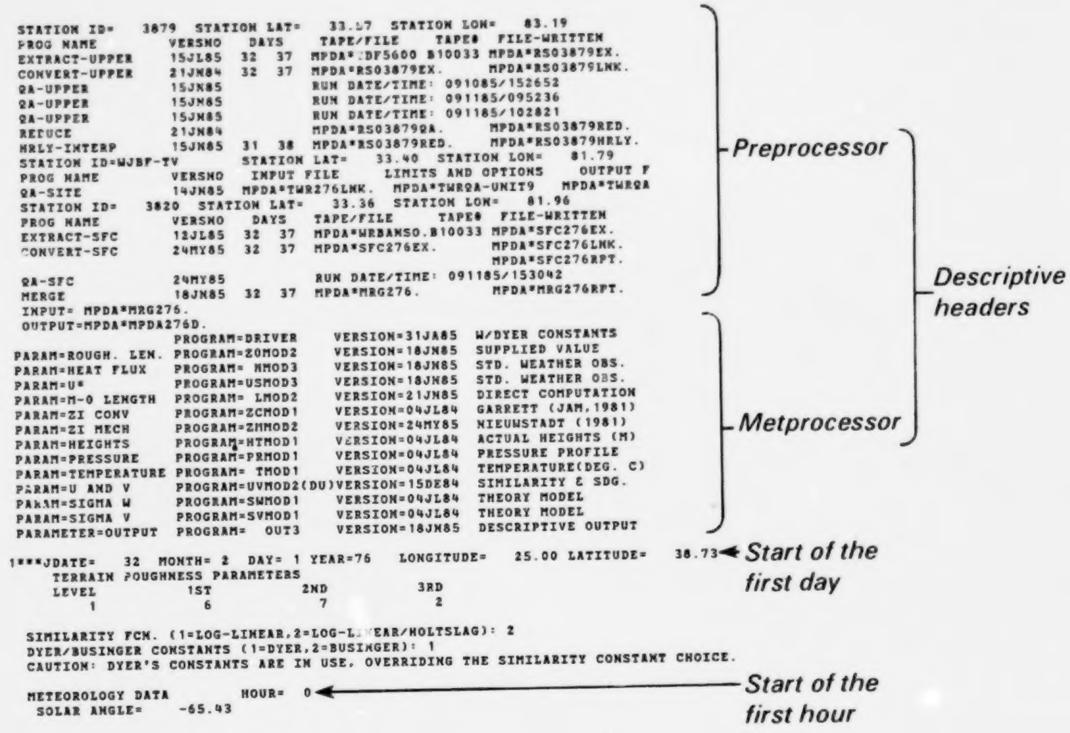


```
IN FILE=MPDA*MRG276.
OUTFILE=MPDA*MPDA276D.
  ERRTYP     PROGRAM    JDATE      HOUR    LEVEL    HEIGHT
    12A       ZMMOD2      33         9
    12A        TMOD1      33         9
    12B       UVMOD2      33         8
    12A       UVMOD2      33         9
    12B       UVMOD2      33        10
    12B       UVMOD2      33        11
    12B       UVMOD2      33        12
    12B       UVMOD2      33        13
    12B       UVMOD2      33        14
    12B       UVMOD2      33        15
    12B       UVMOD2      33        16
    12B       UVMOD2      33        17
    12B       UVMOD2      33        18
    12B       UVMOD2      33        19
    12B       UVMOD2      33        20
    12B       UVMOD2      33        21
    12B       UVMOD2      33        22
    12B       UVMOD2      33        23
    12A       SWMOD1      33         9
    12A       SVMOD1      33         9
    12A       ZMMOD2      34        17
    12A        TMOD1      34        17
    12B       UVMOD2      34         0
    12B       UVMOD2      34         1
    12B       UVMOD2      34         2
    12B       UVMOD2      34         3
    12B       UVMOD2      34         4
    12B       UVMOD2      34         5
    12B       UVMOD2      34         6
    12A       UVMOD2      34        17
    12A       SWMOD1      34        17
    12A       SVMOD1      34        17
    12A       ZMMOD2      35        23
    21        PRMOD1      35        23
    12A        TMOD1      35        23
    12B       UVMOD2      35        20
    12B       UVMOD2      35        21
    12B       UVMOD2      35        22
    12A       UVMOD2      35        23
    12A       SWMOD1      35        23
    12A       SVMOD1      35        23
    15B       ZCMOD1      36         7
    12A       ZMMOD2      36         6
    12A       ZMMOD2      36         7
    21        PRMOD1      36         6
    12B       PRMOD1      36         7
    12B       PRMOD1      36         8
```

Input and output file names
error code
subroutine in which error occurred
day and hour of the error

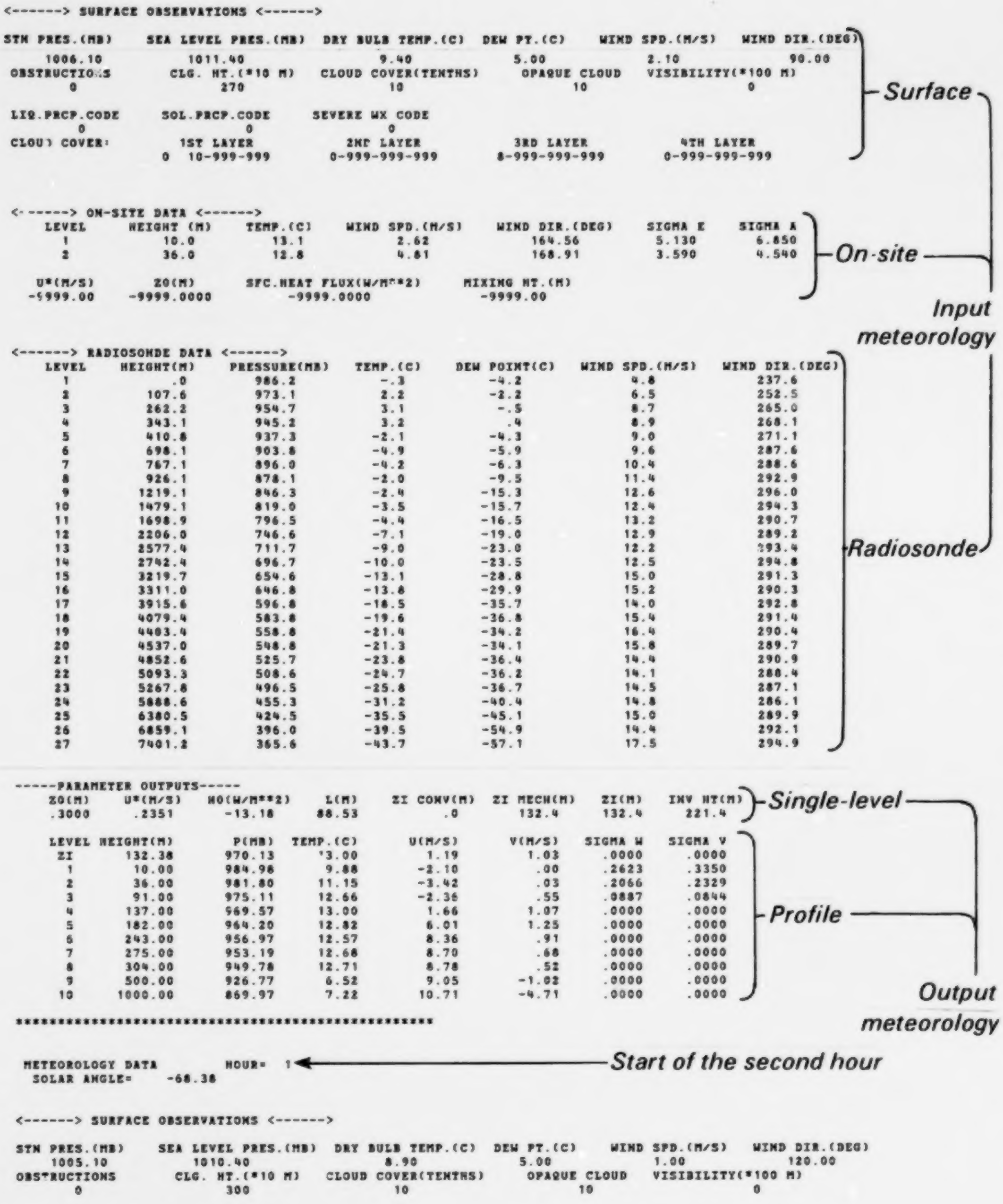
Figure 5.36. Sample of error messages produced by the metprocessor. See Appendix E for explanations of the error codes.

For this sample problem, the metprocessor was rerun with all the same variable selections, except that OUTMOD3, the formatted descriptive output, was used. An annotated sample of the formatted output is shown in Figure 5.37.



```
STATION ID=   3879  STATION LAT=   33.57  STATION LON=   83.19
PROG NAME          VERSNO   DAYS    TAPE/FILE     TAPE#  FILE-WRITTEN
EXTRACT-UPPER      15JL85  32  37  MPDA*:DF5600 B10033 MPDA*RS03879EX.
CONVERT-UPPER      21JN84  32  37  MPDA*RS03879EX.     MPDA*RS03879LNK.
QA-UPPER           15JN85          RUN DATE/TIME: 091085/152652
QA-UPPER           15JN85          RUN DATE/TIME: 091185/095236
QA-UPPER           15JN85          RUN DATE/TIME: 091185/102821
REDUCE             21JN84          MPDA*RS03879QA.     MPDA*RS03879RED.
HRLY-INTERP        15JN85  31  38  MPDA*RS03879RED.    MPDA*RS03879HRLY.
STATION ID=WJBF-TV         STATION LAT=   33.40  STATION LON=   81.79
PROG NAME          VERSNO   INPUT FILE      LIMITS AND OPTIONS    OUTPUT F
QA-SITE            14JN85  MPDA*TWR276LNK.  MPDA*TWRQA-UNIT9   MPDA*TWRQA
STATION ID=   3820  STATION LAT=   33.36  STATION LON=   81.96
PROG NAME          VERSNO   DAYS   TAPE/FILE       TAPE#  FILE-WRITTEN
EXTRACT-SFC        12JL85  32  37  MPDA*WRBANSO.B10033 MPDA*SFC276EX.
CONVERT-SFC        24MY85  32  37  MPDA*SFC276EX.      MPDA*SFC276LNK.
                                                       MPDA*SFC276RPT.

QA-SFC             24MY85          RUN DATE/TIME: 091185/153042
MERGE              18JN85  32  37  MPDA*MRG276.        MPDA*MRG276RPT.
INPUT= MPDA*MRG276.
OUTPUT=MPDA*MPDA276D.
                  PROGRAM=DRIVER      VERSION=31JA85  W/DYER CONSTANTS
PARAM=ROUGH. LEN. PROGRAM=Z0MOD2      VERSION=18JN85  SUPPLIED VALUE
PARAM=HEAT FLUX   PROGRAM= HMOD3      VERSION=18JN85  STD. WEATHER OBS.
PARAM=U*          PROGRAM=USMOD3      VERSION=18JN85  STD. WEATHER OBS.
PARAM=M-O LENGTH  PROGRAM= LMOD2      VERSION=21JN85  DIRECT COMPUTATION
PARAM=ZI CONV     PROGRAM=ZCMOD1      VERSION=04JL84  GARRETT (JAM,1981)
PARAM=ZI MECH     PROGRAM=ZMMOD2      VERSION=24MY85  NIEUWSTADT (1981)
PARAM=HEIGHTS     PROGRAM=HTMOD1      VERSION=04JL84  ACTUAL HEIGHTS (M)
PARAM=PRESSURE    PROGRAM=PRMOD1      VERSION=04JL84  PRESSURE PROFILE
PARAM=TEMPERATURE PROGRAM= TMOD1      VERSION=04JL84  TEMPERATURE(DEG. C)
PARAM=U AND V     PROGRAM=UVMOD2(DU)VERSION=15DE84  SIMILARITY & SDG.
PARAM=SIGMA W     PROGRAM=SWMOD1      VERSION=04JL84  THEORY MODEL
PARAM=SIGMA V     PROGRAM=SVMOD1      VERSION=04JL84  THEORY MODEL
PARAMETER=OUTPUT  PROGRAM=  OUT3      VERSION=18JN85  DESCRIPTIVE OUTPUT

1***JDATE=   32  MONTH= 2  DAY= 1 YEAR=76   LONGITUDE=   25.00 LATITUDE=   38.73
     TERRAIN ROUGHNESS PARAMETERS
     LEVEL           1ST            2ND             3RD
        1              6              7               2

  SIMILARITY FCN. (1=LOG-LINEAR,2=LOG-LINEAR/HOLTSLAG): 2
  DYER/BUSINGER CONSTANTS (1=DYER,2=BUSINGER): 1
  CAUTION: DYER'S CONSTANTS ARE IN USE, OVERRIDING THE SIMILARITY CONSTANT CHOICE.

  METEOROLOGY DATA          HOUR=  0
   SOLAR ANGLE=     -65.43
```

Figure 5.37. Sample of the descriptive output file produced by the metprocessor.



```
<------> SURFACE OBSERVATIONS <------>

STN PRES.(MB)    SEA LEVEL PRES.(MB)  DRY BULB TEMP.(C)  DEW PT.(C)    WIND SPD.(M/S)   WIND DIR.(DEG)
   1006.10          1011.40                  9.40           5.00          2.10                90.00
 OBSTRUCTIONS        CLG. HT.(*10 M)   CLOUD COVER(TENTHS)     OPAQUE CLOUD   VISIBILITY(*100 M)
      0                  270                  10                    10                0

 LIQ.PRCP.CODE       SOL.PRCP.CODE      SEVERE WX CODE
      0                   0                   0
 CLOUD COVER:           1ST LAYER           2ND LAYER            3RD LAYER             4TH LAYER
                    0  10-999-999        0-999-999-999        8-999-999-999         0-999-999-999


 <------> ON-SITE DATA <------>
     LEVEL      HEIGHT (M)     TEMP.(C)     WIND SPD.(M/S)     WIND DIR.(DEG)      SIGMA E     SIGMA A
       1           10.0          13.1            2.62              164.56           5.130       6.850
       2           36.0          12.8            4.81              168.91           3.590       4.540

    U*(M/S)       ZO(M)        SFC.HEAT FLUX(W/M**2)      MIXING HT.(M)
  -9999.00     -9999.0000          -9999.0000               -9999.00


 <------> RADIOSONDE DATA <------>
     LEVEL     HEIGHT(M)       PRESSURE(MB)     TEMP.(C)       DEW POINT(C)     WIND SPD.(M/S)     WIND DIR.(DEG)
       1              .0           986.2           -.3            -4.2               4.8              237.6
       2           107.6           973.1           2.2            -2.2               6.5              252.5
       3           262.2           954.7           3.1             -.5               8.7              265.0
       4           343.1           945.2           3.2              .4               8.9              268.1
       5           410.8           937.3          -2.1            -4.3               9.0              271.1
       6           698.1           903.8          -4.9            -5.9               9.6              287.6
       7           767.1           896.0          -4.2            -6.3              10.4              288.6
       8           926.1           878.1          -2.0            -9.5              11.4              292.9
       9          1219.1           846.3          -2.4           -15.3              12.6              296.0
      10          1479.1           819.0          -3.5           -15.7              12.4              294.3
      11          1698.9           796.5          -4.4           -16.5              13.2              290.7
      12          2206.0           746.6          -7.1           -19.0              12.9              289.2
      13          2577.4           711.7          -9.0           -23.0              12.2              293.4
      14          2742.4           696.7         -10.0           -23.5              12.5              294.8
      15          3219.7           654.6         -13.1           -28.8              15.0              291.3
      16          3311.0           646.8         -13.8           -29.9              15.2              290.3
      17          3915.6           596.8         -18.5           -35.7              14.0              292.8
      18          4079.4           583.8         -19.6           -36.8              15.4              291.4
      19          4403.4           558.8         -21.4           -34.2              16.4              290.4
      20          4537.0           548.8         -21.3           -34.1              15.8              289.7
      21          4852.6           525.7         -23.8           -36.4              14.4              290.9
      22          5093.3           508.6         -24.7           -36.2              14.1              288.4
      23          5267.8           496.5         -25.8           -36.7              14.5              287.1
      24          5888.6           455.3         -31.2           -40.4              14.8              286.1
      25          6380.5           424.5         -35.5           -45.1              15.0              289.9
      26          6859.1           396.0         -39.5           -54.9              14.4              292.1
      27          7401.2           365.6         -43.7           -57.1              17.5              294.9

   -----PARAMETER OUTPUTS-----
     ZO(M)      U*(M/S)     HO(W/M**2)       L(M)        ZI CONV(M)   ZI MECH(M)      ZI(M)      INV HT(M)
     .3000       .2351        -13.18         88.53              .0        132.4        132.4        221.4

     LEVEL HEIGHT(M)              P(MB)   TEMP.(C)          U(M/S)          V(M/S)    SIGMA W     SIGMA V
      ZI       132.38            970.13     13.00            1.19            1.03      .0000       .0000
       1        10.00            984.98      9.88           -2.10             .00      .2623       .3350
       2        36.00            981.80     11.15           -3.42             .03      .2066       .2329
       3        91.00            975.11     12.66           -2.36             .55      .0887       .0844
       4       137.00            969.57     13.00            1.66            1.07      .0000       .0000
       5       182.00            964.20     12.82            6.01            1.25      .0000       .0000
       6       243.00            956.97     12.57            8.36             .91      .0000       .0000
       7       275.00            953.19     12.68            8.70             .68      .0000       .0000
       8       304.00            949.78     12.71            8.78             .52      .0000       .0000
       9       500.00            926.77      6.52            9.05           -1.02      .0000       .0000
      10      1000.00            869.97      7.22           10.71           -4.71      .0000       .0000
   **************************************************

     METEOROLOGY DATA           HOUR=  1
      SOLAR ANGLE=      -68.38

   <------> SURFACE OBSERVATIONS <------>

   STN PRES.(MB)     SEA LEVEL PRES.(MB)  DRY BULB TEMP.(C)  DEW PT.(C)     WIND SPD.(M/S)    WIND DIR.(DEG)
      1005.10            1010.40                8.90            5.00           1.00               120.00
   OBSTRUCTIONS          CLG. HT.(*10 M)   CLOUD COVER(TENTHS)      OPAQUE CLOUD    VISIBILITY(*100 M)
        0                    300                  10                     10                0
```

Figure 5.37. Continued.

USER CHECKLISTS

The following pages contain five checklists for the user. Three of the checklists correspond to the three data pathways in the preprocessor. There is also a checklist for the MERGE program, and one for the metprocessor. These checklists are intended to be brief reminders of key points as the user implements the system. We recommend that these pages be removed from the document and copied, so that the user will have them available as he works. The file names given in the checklists are the same as those used in the sample problem. The user is free to use these names or to assign new names to the files. The card images required as input are described in the tables in Section 4. Error messages are described in Appendix E.

TABLE 5.1. RADIOSONDE DATA PATHWAY EXECUTION CHECKLIST

Programs	User Notes
1. **Run SCAN-UPPR (optional)** Program: MPDAPRE.SCAN-UPPR Input Required: NCDC data tape; card image is Table 4.1. Runstream Example: Fig. 5.2. Output: Report file = MPDA*RSO3879SCAN.; example is Fig. 5.3. Comments: This program should be run once to determine the contents of the data tapes, if unknown.	
2. **Run EXTRACT-UPPR** Program: MPDAPRE.EXTRACT-UPPR Input Required: NCDC data tape; card image is Table 4.2. Runstream Example: Fig. 5.4. Output: Data file = MPDA*RSO3879EX.; example is Fig. 5.5. Comments: The program reads NCDC data tapes in EBCDIC character format. Refer to publication TD5600 (available from NCDC) for details of the tape format.	
3. **Run CONVERT-UPPR** Program: MPDAPRE.CONVERT-UPPR Input Required: Output from EXTRACT-UPPR; card image is Table 4.3; look-up table is Table 4.4. Runstream Example: Fig. 5.6. Output: Data file = MPDA*RSO3879LNK.; format given in Table C.1. Example is Fig. 5.7.	
4. **Run QA-UPPR (optional)** Program: MPDAPRE.QA-UPPR Input Required: File of limits and options = MPDA*QALISTRS.; Table 4.5. Example is Fig. 5.9. Runstream Example: Fig. 5.8. Output: Report of violations = MPDA*RSQAERR.; example is Fig. 5.10. Data file = MPDA*RSO3879QA.; format given in Table C.3, Example is Fig. 5.11. Comments: If the user does not wish to quality assess his data, this step can be omitted. Section 6 contains a more detailed description of the program.	
5. **Run REDUCE (optional)** Program: MPDAPRE.REDUCE Input Required: Card image is Table 4.6. Runstream Example: Fig. 5.12 Output: Data file = MPDA*RSO3879RED.; format given in Table C.5. Example is Fig. 5.13.	
6. **Run HRLY-INTERP** Program: MPDAPRE.HRLY-INTERP Input Required: Output from MPDAPRE.QA-UPPR or MPDAPRE.CONVERT-UPPR; card image is Table 4.7. Runstream Example: Fig. 5.14. Output: Data file = MPDA*RSO3879HRLY.; format given in Table C.8, Example is Fig. 5.15. Comments: Input data can be no more than 12 h apart.	

TABLE 5.2. SURFACE OBSERVATION DATA PATHWAY EXECUTION CHECKLIST

Programs	User Notes
1. Run SCAN-SFC (optional) **Program:** MPDAPRE.SCAN-SFC **Input Required:** NCDC data tape: card image is Table 4.8. **Runstream Example:** Fig. 5.17. **Output:** Report file = MPDA*SFC276SCAN.; example is Fig. 5.18. **Comments:** This program should be run once to determine the contents of the data tape, if unknown.	
2. Run EXTRACT-SFC **Program:** MPDAPRE.EXTRACT-SFC **Input Required:** NCDC data tape; card image is Table 4.9. **Runstream Example:** Fig. 5.19. **Output:** Data file = MPDA*SFC276EX.; example is Fig. 5.20. **Comments:** The program reads NCDC data tapes in EBCDIC character format. Refer to publication TD1440 (available from NCDC) for details of the tape format.	
3. Run CONVERT-SFC **Program:** MPDAPRE.CONVERT-SFC **Input Required:** Output from MPDAPRE.EXTRACT-UPPR; card image is Table 4.10. **Runstream Example:** Fig. 5.21. **Output:** Optional report file = MPDA*SFC276RPT.; example is Fig. 5.23. Data file = MPDA*SFC276LNK.; format is Fig. 5.22.	
4. Run QA-SFC (optional) **Program:** MPDAPRE.QA-SFC **Input Required:** File of limits and options = MPDA*QALISTSFC.; Table 4.11. Example is Fig. 5.25. **Runstream Example:** Fig. 5.24. **Output:** Report of violations = MPDA*SFCQAERR.; example is Fig. 5.26. Data file = MPDA*SFC276QA.; format given in Table C.7, example is Fig. 5.27 **Comments:** If the user does not wish to quality assess his data, this step can be omitted. Section 6 contains a more detailed description of this program.	

TABLE 5.3. ON-SITE QA EXECUTION CHECKLIST

Program	User Notes
NOTE: Because of the variability of formats for on-site data, no SCAN, EXTRACT, or CONVERT programs are provided. The QA program provided here has the same format as MERGE.	
1. Run QA-SITE (optional) **Program:** MPDAPRE.QA-SITE **Input Required:** File of limits and options = MPDA*TWRQA-UNIT9 (Tables 4.12 and 4.13); example is Fig. 5.30. Card image is Table 4.15. Format for user-supplied data is in Table 4.14. **Runstream Example:** Fig. 5.29. **Output:** Report of violations = MPDA*TWRQA-UNIT10 (example is Fig. 5.31. Data file (MPDA*TWRQA-UNIT8) format given in Table 4.14; example is Fig. 5.32. **Comments:** Section 6 contains a more detailed description of the program.	

TABLE 5.4. MERGE EXECUTION CHECKLIST

Program	User Notes
Program: MPDAPRE.MERGE **Input Required:** Radiosonde data file (MPDA*RSO3879RED.) format is in Table C.8. Surface observation data file (MPDA*SFC276QA.) format is in Table C.9. On-site data file (MPDA*TWRQA-UNIT8) format is in Table 4.14. Card image is in Table 4.16. **Runstream Example:** Fig. 5.33. **Output:** Unformatted output file for metprocessor = MPDA*MRG276. Optional report file (MPDA*MRG276RPT.) example is Fig. 5.34. **Comments:** Data must be sequential in time for this program to work properly.	

TABLE 5.5. METPROCESSOR EXECUTION CHECKLIST

Program	User Notes
Program: MPDACODE1.DRIVER **Input Required:** Merged data file (MPDA*MRG276.); card image is Table 4.17. **Runstream Example:** Fig. 5.35. **Output:** Error file (system output device) example is Fig. 5.36. Output is a subroutine. The user can choose unformatted TUPOS-style output (OUT4), formatted descriptive output (OUT3) [see example in Fig. 5.37 and format description in Appendix D], or the user may provide his own output subroutine.	

SECTION 6

TECHNICAL ASPECTS OF THE PREPROCESSOR

This section provides mathematical, meteorological, and procedural details about some of the programs in the preprocessor. This information is not needed to successfully execute the system, but it may help the user to comprehend the logic by which the preprocessor was designed.

The programs in the preprocessor CALL a number of subroutines. A brief description of these subroutines and a list of the programs that CALL them are given in Appendix F.

EXTRACT-UPPR

Because the last standard radiosonde report of the day is for 1200 GMT (e.g., 1200 GMT = 0700 EST), the user should specify on the input card image one Julian day later than the time period of interest. This will avoid the loss of data at the end period when the data are interpolated to hourly reports. For example, 91 through 120 correspond to April in a non-leap year. Specifying 121 rather than 120 insures a full month of data for the metprocessor.

QA-UPPR

After the data have been extracted and the conversions made, errors in the data may exist. Radiosonde data are not easily corrected by automated means because of the variety of possible errors that can occur. This program provides some automatic adjustments, and for other questionable records, it provides the user with a descriptive code word for the type of error suspected. We hope someday to have a fully automated QA program, and we welcome user suggestions to help us achieve that goal.

Temperature, dew point, wind speed, and wind direction are all scanned for values out of range. If a value is out of range, the sounding level record containing the value is written, along with a description of the type of error suspected, to an error report file. The value can be evaluated and adjusted by the user if necessary.

Temperature values above 1000 m are checked for the correct sign. If a temperature greater than 10°C is encountered and the temperature at the level immediately below is negative, the sign on the temperature is changed and the dew point is recomputed. A message, coded as SIGN, is written to the report file whenever a sign change is made.

Missing values of temperature and dew point are estimated by the program when the LOGICAL option TDPFIL is TRUE. Estimates are based on a linear interpolation of each parameter on a logarithmic pressure axis. The lowest level in the report cannot be estimated by this method.

The heights in the report are completely recalculated and require pressure, temperature, and dew point for each level. In addition, the surface station elevation (meters above mean sea level) is required as a starting point for the calculation. If any of these values is missing, the heights for that level and all levels above it cannot be recalculated.

Dew point at a level is checked for a maximum deviation from a linear trend defined by the first available dew point values below and above the level. This excludes the lowest and highest levels from being checked. The absolute value of the deviation is checked against the maximum allowable deviation. We suggest a value of 0.2°C/m for the maximum deviation. A message, coded as TDEW, is written to the report file whenever a deviation exceeds the maximum allowable deviation.

Wind direction is verified to be between 0° and 360°, and wind speed is verified to be greater than zero but less than a user-defined maximum. We suggest a value of 50 m/s for values in the lower troposphere. A message, coded as WDIR for direction violations and WSPD for speed violations, is written to the report file.

Whenever the winds are calm (i.e., the reported value of the wind speed is zero), the direction should also be zero. If the LOGICAL variable CALM is specified as TRUE, wind direction is checked for compliance whenever a wind speed of zero is encountered. A message, coded as CALM, is written to the report file if a violation occurs.

The vector magnitude of the vertical wind shear is checked in the layers between report levels with a bottom more than 100 m above the surface. A suggested value for the maximum shear is 0.05 s^{-1}. A message, coded as WSHR is written to the report file whenever a violation occurs.

The rate of change of temperature with height (temperature lapse rate) is checked in all layers except the lowest layer, which is bounded by the ground. The lapse rate should not be less than a lower (unstable) limit nor greater than an upper (stable) limit. Suggested values for the lower and upper limits are -0.015°C/m and 0.03°C/m, respectively. A message, coded as TSUPR for lower limit violations and TINVR for upper limit violations, is written to the report file.

After the error record file is examined and necessary adjustments are made, the data should be subjected to the QA program until the data set passes through without error. There are no options to exclude variables from quality assessment except for the check for calm wind conditions. However, by setting the limits well outside the range of reasonable values (for example, -9999.0 and 9999.0), there would be no report of a limit violation for the variable. The only exception to this is wind direction, which is constrained to be between 0° and 360°.

HRLY-INTERP

Standard radiosonde ascents are twice-daily, at 0000 GMT and 1200 GMT, but the metprocessor requires radiosonde reports to be hourly. This program interpolates data from radiosonde reports to hourly intervals.

The reports can be no more than twelve hours apart. If they are further apart, then no interpolation is possible for a 24-h period. However, radiosonde reports more frequent than the 12-h period are acceptable, and the program adjusts automatically to the new frequency of reports. With this flexibility, a user can supplement or replace the standard reports with special reports, although the frequency of reports in the input file must remain constant.

The interpolation algorithm works with two radiosonde reports at one time. It searches through the input file until it encounters reports that are within the range of dates specified by the user on the input card (see Section 4) and for which the time difference between the two reports is no greater than 12 h. The heights at which radiosonde data are reported differ from report to report, except for the first level, which is always the surface elevation (above mean sea level). To interpolate over time, the data in the two reports for each day are set at the same heights. It is the function of the subroutine RALIGN to produce two radiosonde reports for each day with data at the same heights. If the radiosonde reports are more than 12 h apart, all atmospheric variables at all levels are specified as missing (-9999.0) for the hours between the two reports.

QA-SFC

This program evaluates the surface observation data most often used by the metprocessor. The program requires input data in the format given in Section 4. One output file produced by the QA program is a report of the records that contain data that violate the limits checks. The second output file is used by MERGE. If any of the checked data values violate the limits, the values are set to missing (-9999.0) before the record is written to the output file.

The tests for invalid data in the input file consist of limits checks. No automatic adjustments are provided. We welcome user suggestions for automating this QA program. Temperature values are checked for minimum and maximum limits defined as follows:

$$T_{MIN} = T_{MIN0} - (\phi - \phi_0) \frac{d(TMIN)}{d\phi} \qquad (6.1)$$

$$T_{MAX} = T_{MAX0} - (\phi - \phi_0) \frac{d(TMAX)}{d\phi}, \qquad (6.2)$$

where T_{MIN0} and T_{MAX0} are base temperatures defined by the user, ϕ = station latitude, ϕ_0 = base latitude (defined by the user), and $d(TMIN)/d\phi$ and $d(TMAX)/d\phi$ are the user-defined variations of temperature with latitude. The limits for ambient air temperature and dew point are computed by this method. A missing station latitude will prevent temperature from being checked unless $d(TMIN)/d\phi$ and $d(TMAX)/d\phi$ are specified as zero.

All wind directions and wind speeds are checked for compliance with the following:

$$0° \le \text{DIRECTION} \le 360°, \text{ and } 0 \le \text{SPEED} \le WS_{max}, \qquad (6.3)$$

where WS_{max} is a user-defined maximum speed.

Sea level pressure is checked for violations of user-defined minimum and maximum values. The user should consult local and regional climatological tables to determine reasonable values based on latitude and season.

QA-SITE

NWS radiosonde and surface weather observations are probably not recorded at the site at which dispersion analyses are applied. User-supplied on-site data, if it is available, is recommended. Data can be obtained from an instrumented tower or by using a remote sensing technique, such as sodar, lidar, or radar. The MPDA-1 includes a QA program for on-site data. The user will first have to format his data according to the specifications given in Section 4.

The QA program for on-site data primarily checks whether a value is within a range of allowable values. There are provisions for checking approximately 20 variables that are measured at more than one level (with a maximum of 15 levels), and for checking 9 single-level parameters including surface friction velocity, surface heat flux density, surface roughness length, and mixing height. In addition to the limits checks, the change in temperature with height (lapse rate) can be evaluated. A message is written to the report file whenever a violation is detected.

The options input file contains the LOGICAL options that specify whether or not a variable is to be checked, and if an evaluation is desired (option is TRUE); information on the range of values is also specified. Default values are provided for convenience. It is recommended that the default values be tailored to the particular analysis of the user.

MERGE

MERGE combines the data (radiosonde, surface weather observations, and on-site) into an unformatted file consisting of a sequence of unformatted day-records. A day-record is defined as one day of output containing 19,378 elements, with 24 hourly observations of the radiosonde, surface observation, and on-site data.

On the input card (see Section 4), the user specifies the first and last Julian day of the year to be merged. Any range of dates can be specified, up to one calendar year (1 January - 31 December). Beginning with the first Julian day specified, MERGE searches the radiosonde input file until the first hour of the correct day is encountered. The data in the radiosonde report are entered into the variables of the COMMON block DAYMET. If the day and hour are not present, the missing value indicator (-9999.0) is inserted for all the variables for the hour. Processing continues with the surface observation input file and on-site data for the first hour. This repeats for the remaining 23 h of the day. When one day is completed, the contents of DAYMET are written (unformatted) to the output file. Each day in the range of Julian days is processed in an identical manner. The result is an unformatted (binary) file beginning with the first Julian day specified and ending with the last day specified.

MERGE eliminates missing time periods in the input files by filling the output file with the missing value indicator for the hour. If one or more of the input data sets is unavailable, an empty file should be attached to the logical file number of the missing data set. The variables that normally appear in the empty file will appear as missing values for all hours on all days in the merged file.

SECTION 7

COMPUTER ASPECTS OF THE SYSTEM

INTRODUCTION

This section discusses computer aspects of the system, including information on problems with executing the system, the structure of the metprocessor, and how to add a method (subroutine) to the metprocessor. The programs and subroutines share a number of characteristics:

1. The programs were designed by using the principles of Jackson Structured Programming (Jackson, 1975).
2. Excluding the EXTRACT programs, all missing values are signified by -9999.0 for real variables and -9999 for integer variables. The input data to the EXTRACT programs have their own indicators for missing values. These values are extracted without modification but are converted to -9999.0 or -9999 by the CONVERT programs.
3. After every READ statement, input status is checked to verify that the READ was successful. If it was successful, processing continues; if it encounters an end-of-file (EOF) mark, the action taken depends on the location of the EOF; for any other change in input status, a message is issued to the user and processing stops.
4. Input cards are read through logical file 5 (the system's input device file) in a list-directed (free) format.
5. ANSI FORTRAN 77 was used to encode all software except for two nonstandard FORTRAN statements: INCLUDE and NAMELIST. This is discussed in more detail below.

The software was developed and tested on the Sperry UNIVAC 1100/82 at the National Computer Center at the U.S. Environmental Protection Agency's site in Research Triangle Park, North Carolina. System specifications provided in this section (see Table 7-1) refer to the UNIVAC.

TABLE 7.1. UNIVAC SYSTEM SPECIFICATIONS

Program	Logical Unit No.*	Compile Time (SRUs)	Map Time (SRUs)**	Memory (36-bit words)	Execution Time (SRUs)**	Size†
SCAN-UPPR[1]	I = 10; O = 7	0:09	0:54	17.7K	3:30	30
EXTRACT-UPPR	I = 7; O = 8	0:19	0:58	17.9K	3:49	3400
CONVERT-UPPR	I = 8; O = 9	0:13	1.07	13.0K	0.31	3400
QA-UPPR	I = 10; O = 12 L = 9 ER = 11	0:10	1:08	14.4K	0:39	L: 8 ER: 4 O: 340
REDUCE	I = 10; O = 11	0:13	0:54	11.1K	3:19	1800
HRLY-INTERP	I = 9; O = 10	0:23	1:07	30.0K	4:24	20,000
SCAN-SFC	I = 10; O = 8	0:10	0:55	9.4K	4:49	10
EXTRACT-SFC	I = 7; O = 8	0:18	0:54	12.8K	5:06	1400
CONVERT-SFC	I = 8; O = 9 R = 10	0:12	0:57	11.7K	0:41	O: 1400 R: 7900
QA-SFC	I = 10; O = 12 L = 9 ER = 11	0:10	0:51	11.3K	0:24	L: 10 ER: 5 O: 1400
QA-SITE[2]	I = 7; O = 8 L = 9 ER = 10	1:07	1:08	19.6K	1:41	L: 40 ER: 900 O: 13,700
MERGE	RI = 15 OSI = 16 SOI = 17 FO = 24 UO = 25	0:53	1:10	37.8K	6:53	FO: 73,000
METPROCESSOR[3]	I = 25; O = 8 ER = 9	0:36	1:39	62.3K	13:53	55,100

* I = input; O = output; L = input of limits and options; ER = error report; R = report output; RSI = radiosonde input; OSI = on-site input; SOI = surface observation input; FO = formatted output; UO = unformatted output.

** SRUs = a single measure representing all the cost components (CPU, memory, I/O), expressed in minutes and seconds.

† Size = number of 132-character (maximum) formatted records; numbers are approximate.

[1] Program scanned an NWS magnetic tape (1600 BPI, 44,000 observations).

[2] On-site data had two levels.

[3] Program executed for one day; execution time and size extrapolated for 29 days (Feb. 1976).

PROBLEMS WITH EXECUTING THE SYSTEM

Nonstandard FORTRAN

If the user encounters problems when compiling the programs, it may be due to the use of nonstandard FORTRAN features in the current version of the programs. The source code for the COMMON blocks and associated declarative statements required by MERGE and the metprocessor are read from a separate file by the FORTRAN compiler. This process gives the user the convenience of working with COMMON blocks in one location. It involves the nonstandard FORTRAN statement called INCLUDE that is available on the Sperry UNIVAC. On the UNIVAC, the INCLUDE statement specifies that the contents of a subdivision or module of the file (called a PROC) be incorporated in the FORTRAN compilation. The form of the INCLUDE statement in the FORTRAN source code is as follows:

```
INCLUDE     filename.PROC name, LIST
```

This is placed near the beginning of the source code with the declarative statements. The LIST qualifier indicates that the PROC contents are to be listed in the compilation source listing. Descriptions of the structure and contents of the PROCs in the metprocessor are included in the discussion of the structure of the metprocessor later in this section.

The INCLUDE statement and associated PROCs may not be recognizable to a different compiler. The user should determine if the INCLUDE or similar statement is available on his system and make the necessary adjustments, so MERGE and the metprocessor will have access to the COMMON blocks and other declarative statements. If there is no INCLUDE or similar statement, then the COMMON blocks and declarative statements can be explicitly entered into all programs and subroutines that require the PROCs.

The NAMELIST statement defines a list of variable or array names and associates the list with a group name. In lieu of an input/output list, the group name is used in a NAMELIST-directed input/output statement to define the variables or arrays that are to be read or written. The form of the NAMELIST is as follows:

NAMELIST/group name/list of variable or array names

The form of the output statement is as follows:

WRITE ([UNIT=] unit number, [NML=] group name)

The brackets indicate optional key words.

In an input statement, READ replaces WRITE. The file that is read must be structured according to the requirements of the computer system. On the UNIVAC, the first line must be as follows: $group name. The first line must begin in column 2. The variable names and values follow in any order and have the following form: variable name = value,. The comma is required after each assignment except the last one. The final line of the file is as follows: $END. This line must begin in column 1. The upper air and surface data QA programs (QA-UPPR and QA-SFC, respectively) use the NAMELIST to input the limits. Examples of their file structures, can be found in Figures 5.9 and 5.30.

The user should consult his system user's guide to determine the applicability of these statements. If the programs do not compile because of the presence of NAMELIST-directed input/output, the user should restructure the READ and WRITE statements to conform to ASCII FORTRAN standards, with input and output lists and FORMAT statements.

Additional problems with executing the system may be due to a failure to meet the data requirements of the preprocessor. The following data requirements must be met to prevent failure of the preprocessor programs.

1. The count for the number of descriptive header records must be present and specified correctly. If there are no header records, a zero must appear on the first line of the input file.
2. The number of radiosonde levels reported in the header of each report must agree with the actual number of levels.
3. All values for temperature and dew point must be present in QA-UPPR, unless the automatic estimation facility has been activated.
4. For the REDUCE program, the height of the first level must be present.
5. In QA-SFC, station latitude must be specified. If station latitude is missing, then the change of temperature per degree of latitude ($dT/d\phi$ in Section 6) should be specified as zero.
6. MERGE requires all input files to be correctly formatted.
7. For MERGE, the days and times must be ordered sequentially. If they are not, the program does not stop, but MERGE will not locate all the available data to write to the output file.

Configuration of MPDA Files on the NTIS Tape

The NTIS tape contains seven MPDA files, with an EOF mark after each one, in the following order: 1) preprocessor programs, 2) PROCs, 3) library routines, 4) metprocessor, 5) sample upper air data, 6) sample surface observation data, and 7) sample on-site data. The exact location of these files on the NTIS tape can be obtained from the first file on the tape. Blocking for the program files consists of 80 characters per record with 10 records per block. Upper air and surface observation data are as they are received from NWS, except the data have already been converted to ASCII character format. The on-site data are blocked at 120 characters per record with 10 records per block.

Each file on the tape retains the structural configuration of a UNIVAC program file and the same information. A program file is a named set of elements residing on mass storage and the elements are the individual FORTRAN source programs and subroutines. In creating these files for the tape, the elements in a program file were concatenated and each was separated by the following delimiter:

```
#ELT,<options> MPDA*program file (1).element
```

where <options> are UNIVAC options for the ELT processor, and (1) is a cycle number. Thus, if the MPDA programs are implemented on another UNIVAC, the program file and elements can be recreated quickly by using the ELT processor.

On a DEC VAX, the user would replace the delimiters with the following:

```
$ CREATE/LOG [user id. program file] element.FOR
```

where the UNIVAC program file is a VAX subdirectory, and the element is a VAX file name. The user would create a runstream of VAX control language to extract and retain the programs.

If such capabilities are not available on the user's system, the delimiters provide a method to locate the programs within an editor. The programs can be written to separate files using the editor or similar facility.

The FORTRAN PROCs have a different delimiter:

```
#PDP,<options> MPDA*program file (1).element
```

where <options> and (1) are the same as for program elements. There is one PROC for the MERGE program and metprocessor and a second PROC for the on-site QA program and its subroutines. As with the program elements, a

UNIVAC processor (or similar commands on another system), can recreate these files, or the PROCs can be edited and placed in separate files.

The order of the files (UNIVAC program files) and elements on the tape are given in Table 7.2.

TABLE 7.2. ORDER OF THE UNIVAC PROGRAM FILES AND ELEMENTS ON THE NTIS TAPE

File No.	File Name	File Elements (in alphabetical order)
1	MPDAPRE. (preprocessor programs)	CONVERT-SFC, CONVERT-UPPR, EXTRACT-SFC, EXTRACT-UPPR, HRLY-INTERP, MERGE, QA-SFC, QA-SITE, QA-UPPR, REDUCE, SCAN-SFC, SCAN-UPPR
	(preprocessor subroutines)	OUT2, OUTRPT, OUTUNF, P1MSUB, P2MSUB, RALIGN, READU9, SHRINK, TALLYS, TWRSUB, UVCOMP, WDWSUV
2	MPDAMPROCS. (COMMON blocks)	PROCS1 (for MERGE and the metprocessor), PROCS3 (for QA-SITE)
3	MPDALIB. (library routines)	ATAPE, CHRON, EBCASC, ERRMSG, FASMOV, GMTLST, GREG, HTCALC, IOCL, JULIAN, RACHEK, SGNCHK, TDPEST
4	MPDACODE1. (metprocessor main program)	DRIVER
	(metprocessor subroutines)	ERRTBL, HMOD1, HMOD3, HMOD4, HTMOD1, HTMOD2, INTERP, LMOD2, NEWFCN, OUT3, OUT4, PRMOD1, SOLANG, SVMOD1, SVMOD2, SWMOD1, SWMOD2, TMOD1, USMOD1, USMOD3, USMOD4, UVMOD2, UVMOD3, UVMOD4, ZOMOD1, ZOMOD2, ZCMOD1, ZCMOD2, ZCMOD3, ZMMOD1, ZMMOD2, ZMMOD3

The program files are followed by three data files for testing purposes. In the order they appear on the tape, they are upper air, surface observation, and on-site data. The upper air and surface observation data are exactly as they would be received on an NWS tape from Asheville, NC, except that THE DATA HAVE ALREADY BEEN CONVERTED TO ASCII CHARACTER FORMAT. Thus, to test the programs, the conversion of EBCDIC to ASCII should be omitted. The on-site data are in a format ready for the on-site QA (QA-SITE). Neither the data set nor the programs need modification.

Table 7.3 provides a list of the subroutines and PROCs required by the main programs. The user should note that OUT4 in MPDACODE1. requires tne system routine ADATE. An installation checklist (Table 7.5), similar in format to the checklists in Section 5, appears at the end of this section. This checklist outlines the steps necessary to produce executable code.

TABLE 7.3. SUBROUTINES AND PROCs REQUIRED BY THE MAIN PROGRAMS

Program	Subroutines (UNIVAC Element Name)	PROCs
MPDAPRE.SCAN-UPPR	MPDALIB: ATAPE, EBCASC, IOCL, JULIAN	—
MPDAPRE.EXTRACT-UPPR	MPDALIB: ATAPE, EBCASC, IOCL, JULIAN	—
MPDAPRE.CONVERT-UPPR	MPDALIB: GMTLST, GREG, IOCL MPDAPRE: P1MSUB*, P2MSUB*	—
MPDAPRE.QA-UPPR	ADATE** MPDALIB: ERRMSG, HTCALC, RACHECK, SGNCHK, TDPEST	—
MPDAPRE. REDUCE	MPDALIB: IOCL	—
MPDAPRE.HRLY-INTERP	MPDALIB: CHRON, FASMOV, GREG, IOCL, JULIAN MPDAPRE: RALIGN, SHRINK, UVCOMP, WDWSUV	—
MPDAPRE.SCAN-SFC	MPDALIB: ATAPE, EBCASC, IOCL, JULIAN	—
MPDAPRE.EXTRACT-SFC	MPDALIB: ATAPE, EBCASC, IOCL, JULIAN	—
MPDAPRE.CONVERT-SFC	MPDALIB: IOCL MPDAPRE: P2MSUB*	—
MPDAPRE.QA-SFC	ADATE**	—
MPDAPRE.QA-SITE	MPDALIB: IOCL MPDAPRE: READU9, TALLYS, TWRSUB*	PROCS3
MPDAPRE.MERGE	MPDALIB: IOCL, JULIAN MPDAPRE: OUTRPT, OUTUNF, OUT2	PROCS1
MPDACODE1.DRIVER	MPDACODE1: ERRTBL, HMOD1, HMOD3, HMOD4, HTMOD1, HTMOD2, INTERP, LMOD2, NEWFCN, OUT3, OUT4, PRMOD1, SOLANG, SVMOD1, SVMOD2, SWMOD1, SWMOD2, TMOD1, USMOD1, USMOD3, USMOD4, UVMOD2, UVMOD3, UVMOD4, ZOMOD1, ZOMOD2, ZCMOD1, ZCMOD2, ZCMOD3, ZMMOD1, ZMMOD2, ZMMOD3	PROCS1

* This subroutine contains several entry points, not all of which are used by the calling program.

** A system routine that returns the system date and time. There are two arguments for this routine. The first is the date and the second is the time. Both are declared type CHARACTER * 8.

STRUCTURE OF THE METPROCESSOR

The metprocessor consists of a main program and primary and secondary subroutines. The primary subroutines contain the methods for computing meteorological parameters and constructing one-dimensional vertical profiles of atmospheric variables. The secondary subroutines contain the intermediate computations required by the primary subroutines.

Data are transferred between the DRIVER and subroutines by means of COMMON blocks. The COMMON blocks are retained in a separate file subdivided into modules called PROCS, as discussed earlier. There are four major COMMON blocks: DAYMET, which is for the input meteorology; METOUT and COMPRM, for the output meteorology; and USRPRM, for the variables used to select the methods of calculation. The COMMON blocks and associated declarative statements are given in Figure 7.1 as they appear in the source code.

Limits on array sizes are in the declarative statements. In particular, the maximum number of levels allowed is 40 in a radiosonde report (variable name IRSLEV) and 15 for on-site data (variable name ISTLEV). Both are defined in a PARAMETER statement in the unit containing the COMMON block DAYMET. The maximum number of user-supplied profile heights, defined in the unit containing METOUT, is 20 (variable name HTLEV).

The metprocessor operates on a 24-h clock, from midnight to midnight. The initial hour (MINHR) is set at 0, and the final hour (MAXHR) is set at 23. Both values are defined in the unit containing the COMMON block DAYMET. If alternate initial and final hours (e.g., 1 and 24) are desired, redefine MINHR and MAXHR.

The computation for surface roughness length and many of the other computations in the metprocessor requires the von Karman constant, and several computations require a set of similarity constants. The user specifies either the constants suggested by Dyer and Hicks (1970) or those suggested by Businger et al. (1971). The values for these constants are given in Table 7.4.

TABLE 7.4. CHOICE OF SETS OF CONSTANTS USED BY THE METPROCESSOR

Constants or Functions	Coded Variable Name	Dyer	Businger
von Karman constant	VONKK	0.4	0.35
surface similarity functions	BETA	5.0	4.7
	BETAP	5.0	4.7
	GAMMA	16.0	15.0
	GAMMAP	16.0	9.0
	R	1.0	0.74

```
INOUT PROC
C..................................................................
C INOUT - CONTAINS UNIT NUMBER DEFINITIONS FOR I-O FILES
C..................................................................
      INTEGER INDEV,OUTDEV,ERROUT,USRDEV
C---   INITIALIZE METEOROLOGY INPUT FILE UNIT
      PARAMETER INDEV=25
C
C---   INITIALIZE OUTPUT FILE UNIT
      PARAMETER OUTDEV=8
C
C---   INITIALIZE ERROR FILE UNIT
      PARAMETER ERROUT=9
C
C---   INITIALIZE MODEL SELECTION INPUT UNIT
      PARAMETER USRDEV=5
 END
C
C------------------------------------------------------------------
DAYMET   PROC
C
C..................................................................
C DAYMET - CONTAINS MERGED RS,SO,AND TOWER DATA.
C..................................................................
      INTEGER MINHR,MAXCOL,MAXROW,MAXHR,IRSLEV,HR,ISTLEV
      PARAMETER MINHR=0,MAXHR=23,IRSLEV=40,MAXCOL=1,MAXROW=3,ISTLEV=15,
     *NWVLN=5
      CHARACTER*16 SOCLD1,SOCLD2,SOCLD3,SOCLD4
      DIMENSION BUFF(19378)
      INTEGER SOVIS,SOCHGT,SOSVRE,SOPPT,SOSNOW,SOOBST
      INTEGER SOOPQ,SOCLD
      INTEGER JDATE,IYR,IMO,IDA
      INTEGER TERAIN,NUMTER,SITLEV
      INTEGER NLEV,SITNWV,SITSNC,SITSKY
      REAL LON,LAT,RSPRES,RSDWPT,RSTEMP,RSHGT,RSWSPD,RSWDIR
      REAL SITWSP,SITWDR,SITSGA,SITSGE,SITTMP,SITHGT,SITU,SITV
      REAL SITW,SITDEN,SISGDN,SITRH,SITSGU,SITSGV,SITSGW
      REAL SITSGD,SITSGT,SISGRN,SISGSN,SITMEA,SISGWS,SITSH
      REAL SITDP,SITPRS,SITRDW,SITRAD,SI%UST,SITZI,SITWT,SITZ0
      REAL SITWG,SITLPT,SITSPT
      REAL SOSLP,SOPRES,SOTD,SOWDIR,SOWSPD,SOTEMP
C
       COMMON/DAYMET/JDATE,LON,LAT,IYR,IMO,IDA,NUMTER,
     *TERAIN(MAXCOL,MAXROW),SITLEV(MINHR:MAXHR),NLEV(MINHR:MAXHR),
     *RSHGT(MINHR:MAXHR,IRSLEV),RSPRES(MINHR:MAXHR,IRSLEV),
     *RSTEMP(MINHR:MAXHR,IRSLEV),RSDWPT(MINHR:MAXHR,IRSLEV),
     *RSWSPD(MINHR:MAXHR,IRSLEV),RSWDIR(MINHR:MAXHR,IRSLEV),
     *SITWSP(MINHR:MAXHR,ISTLEV),SITWDR(MINHR:MAXHR,ISTLEV),
     *SITSGA(MINHR:MAXHR,ISTLEV),SITSGE(MINHR:MAXHR,ISTLEV),
     *SITTMP(MINHR:MAXHR,ISTLEV),SITHGT(MINHR:MAXHR,ISTLEV),
     *SITDP(MINHR:MAXHR,ISTLEV),SITPRS(MINHR:MAXHR,ISTLEV),
     *SITU(MINHR:MAXHR,ISTLEV),SITV(MINHR:MAXHR,ISTLEV),
     *SITW(MINHR:MAXHR,ISTLEV),SITDEN(MINHR:MAXHR,ISTLEV),
     *SISGDN(MINHR:MAXHR,ISTLEV),SITRH(MINHR:MAXHR,ISTLEV),
     *SITSGU(MINHR:MAXHR,ISTLEV),SITSGV(MINHR:MAXHR,ISTLEV),
     *SITSGW(MINHR:MAXHR,ISTLEV),SITSGD(MINHR:MAXHR,ISTLEV),
     *SITSGT(MINHR:MAXHR,ISTLEV),SISGRN(MINHR:MAXHR,ISTLEV),
     *SISGSN(MINHR:MAXHR,ISTLEV),SITMEA(MINHR:MAXHR,ISTLEV),
     *SISGWS(MINHR:MAXHR,ISTLEV),SITSH(MINHR:MAXHR,ISTLEV),
     *SITUST(MINHR:MAXHR),SITZI(MINHR:MAXHR),SITSKY(MINHR:MAXHR),
     *SITWT(MINHR:MAXHR),SITZ0(MINHR:MAXHR),SITWG(MINHR:MAXHR),
     *SITLPT(MINHR:MAXHR),SITSPT(MINHR:MAXHR),SITSNC(MINHR:MAXHR)
      COMMON/DAYMET/SITRDW(MINHR:MAXHR,ISTLEV,NWVLN),
     *SITNWV(MINHR:MAXHR,ISTLEV),SITRAD(MINHR:MAXHR,ISTLEV,NWVLN),
     *SOSLP(MINHR:MAXHR),SOPRES(MINHR:MAXHR),
     *SOTD(MINHR:MAXHR),SOWDIR(MINHR:MAXHR),SOWSPD(MINHR:MAXHR),
     *SOTEMP(MINHR:MAXHR),SOOBST(MINHR:MAXHR),
     *SOCHGT(MINHR:MAXHR),SOVIS(MINHR:MAXHR),
     *SOPPT(MINHR:MAXHR),SOSVRE(MINHR:MAXHR),SOSNOW(MINHR:MAXHR),
     *SOOPQ(MINHR:MAXHR),SOCLD(MINHR:MAXHR),SOCLD1(MINHR:MAXHR),
     *SOCLD2(MINHR:MAXHR),SOCLD3(MINHR:MAXHR),SOCLD4(MINHR:MAXHR)
```

input file logical file

output file logical file

system output device

system input device

beginning and ending hours for each day; maximum number of levels for the radiosondes; array dimensions for TERAIN, the surface roughness features; maximum number of levels of on-site levels; maximum number of radiation bands

input meteorology

Figure 7.1. COMMON blocks and declarative statements as they appear in the source code. References to system device numbers are UNIVAC-specific.

```
      EQUIVALENCE(BUFF(1),JDATE)

C  DATA DICTIONARY:
C   VARIABLE            DESCRIPTION
C***MISCELLANEOUS PARAMETERS
C  TERAIN(COL,ROW) TERRAIN ROUGHNESS ARRAY
C  NUMTER          NUMBER OF USER SELECTED ROWS FOR TERAIN ARRAY
C***HEADER PARAMETERS
C  JDATE            JULIAN DATE
C  LON              LONGITUDE OF SITE:  SPECIFIED BY USER ON INPUT CARD
C                   FOR MERGE
C  LAT              LATITUDE OF SITE:  SPECIFIED BY USER ON INPUT CARD
C                   FOR MERGE
C  IYR              YEAR AS TAKEN FROM RADIOSONDE DATA
C  IMO              MONTH AS TAKEN FROM RADIOSONDE DATA
C  IDA              DAY AS TAKEN FROM RADIOSONDE DATA
C  NLEV(HR)         NO.OF LEVELS IN RADIOSONDE FOR THE HOUR
C***RADIOSONDE PARAMETERS
C  RSHGT(HR,LEV)    HEIGHT (M)
C  RSPRES(HR,LEV)   PRESSURE (MB)
C  RSTEMP(HR,LEV)   TEMPERATURE (DEG. C)
C  RSDWPT(HR,LEV)   DEW POINT (DEG. C)
C  RSWDIR(HR,LEV)   WIND DIRECTION (DEG. FROM NORTH)
C  RSWSPD(HR,LEV)   WIND SPEED (M/S)
C***ON-SITE PARAMETERS
C  SITLEV(HR,LEV)   NUMBER OF HEIGHTS FOR THE HOUR
C  SITWT(HR)        KINEMATIC HEAT FLUX (K M/S)
C  SITZI(HR)        MIXING HEIGHT (M)
C  SITUST(HR)       SURFACE FRICTION VELOCITY (M/S)
C  SITZO(HR)        SURFACE ROUGHNESS LENGTH (M)
C  SITWG(HR)        WIND GUST (M/S)
C  SITLPT(HR)       TOTAL LIQUID PRECIPITATION (MM)
C  SITSPT(HR)       TOTAL SOLID PRECIPITATION (MM)
C  SITSNC(HR)       SNOW DEPTH (CM)
C  SITSKY(HR)       NUMERIC DESCRIPTION OF SKY CONDITIONS
C  SITRDW(HR,LEV)   WAVELENGTH AT WHICH RADIATIVE FLUX
C                   IS MEASURED
C  SITWSP(HR,LEV)   WIND SPEED (M/S)
C  SITWDR(HR,LEV)   WIND DIRECTION (DEGREES FROM NORTH)
C  SITSGA(HR,LEV)   HORIZONTAL WIND DIRECTION FLUCTUATIONS (DEGREES)
C  SITSGE(HR,LEV)   VERTICAL WIND DIRECTION FLUCTUATIONS (DEGREES)
C  SITTMP(HR,LEV)   TEMPERATURE (DEG. C)
C  SITHGT(HR,LEV)   HEIGHT OF MEASUREMENTS (M)
C  SITDP(HR,LEV)    DEW POINT (DEG. C)
C  SITPRS(HR,LEV)   PRESSURE (MB)
C  SITU(HR,LEV)     U-COMPONENT (M/S)
C  SITV(HR,LEV)     V-COMPONENT (M/S)
C  SITW(HR,LEV)     W-COMPONENT (M/S)
C  SITDEN(HR,LEV)   DENSITY OF AIR (KG/M**3)
C  SISGDN(HR,LEV)   UNUSED
C  SITRH(HR,LEV)    RELATIVE HUMIDITY (%)
C  SITSH(HR,LEV)    SPECIFIC HUMIDITY (G/KG)
C  SITMEA(HR)       MEAN ELEVATION ANGLE OF THE WIND VECTOR (DEGREES)
C  SITSGU(HR,LEV)   STD DEV OF U-COMPONENT (M/S)
C  SITSGV(HR,LEV)   STD DEV OF V-COMPONENT (M/S)
C  SITSGW(HR,LEV)   STD DEV OF W-COMPONENT (M/S)
C  SITSGD(HR,LEV)   STD DEV OF DEW POINT (DEG. C)
C  SITSGT(HR,LEV)   STD DEV OF TEMPERATURE (DEG. C)
C  SISGRH(HR,LEV)   STD DEV OF REL HUMIDITY (%)
C  SISGSH(HR,LEV)   STD DEV OF SPECIFIC HUM (G/KG)
C  SITNWV(HR)       NUMBER OF WAVE LENGTHS FOR RAD FLUX
C  SITRAD(HR,LEV,WL)RADIATIVE FLUX PER WAVELENGTH WL
C***SURFACE OBSERVATION PARAMETERS
C  SOSLP(HR)        SEA LEVEL PRESSURE (MB)
C  SOPRES(HR)       STATION PRESSURE (MB)
C  SOTD(HR)         DEW POINT (DEG. C)
C  SOWDIR(HR)       WIND DIRECTION (DEGREES FROM NORTH)
C  SOWSPD(HR)       WIND SPEED (M/S)
C  SOSVRE(HR)       SEVERE WEATHER CODE
C  SOSNOW(HR)       FROZEN PRECIPITATION CODE
C  SOOBST(HR)       OBSTRUCTIONS TO VISION CODE
C  SOTEMP(HR)       DRY BULB TEMPERATURE (DEG. C)
C  SOOPQ(HR)        OPAQUE CLOUD AMOUNT
C  SOCHGT(HR)       CEILING HEIGHT (DECAMETERS)
C  SOVIS(HR)        HORIZONTAL SURFACE VISIBILITY (100S OF METERS)
C  SOPPT(HR)        LIQUID PRECIP CODE
C  SOCLD(HR)        TOTAL CLOUD COVER(TENTHS)
C  SOCLD1(HR)       FIRST LAYER CLOUD DATA TYPE
C  SOCLD2(HR)       SECOND LAYER CLOUD DATA TYPE
C  SOCLD3(HR)       THIRD LAYER CLOUD DATA TYPE
C  SOCLD4(HR)       FOURTH LAYER CLOUD DATA TYPE
 END
C
C
```

Figure 7.1. Continued.

```
C----------------------------------------------------------------
METOUT  PROC
C
C...............................................................
C METOUT -CONTAINS COMPUTED PARAMETERS FROM THE MET PROCESSOR
C...............................................................
C
      INTEGER HTLEV
      PARAMETER HTLEV=20
      REAL MOL,PRES,ZIPRES
      REAL Z0,USTAR,HSF,ZICONV,ZIMECH
      REAL ZI,ZITEMP,ZIU,ZIV,ZISW,ZISV,TEMPS
      REAL WNDU,WNDV,SIGW,SIGV,ZHI
      COMMON / METOUT /Z0(MINHR:MAXHR),USTAR(MINHR:MAXHR),
     *HSF(MINHR:MAXHR),MOL(MINHR:MAXHR),ZICONV(MINHR:MAXHR),
     *ZIMECH(MINHR:MAXHR),ZI(MINHR:MAXHR),ZIPRES(MINHR:MAXHR),
     *ZITEMP(MINHR:MAXHR),ZIU(MINHR:MAXHR),ZIV(MINHR:MAXHR),
     *ZISW(MINHR:MAXHR),ZISV(MINHR:MAXHR),ZHI(MINHR:MAXHR),
     *PRES(MINHR:MAXHR,HTLEV),TEMPS(MINHR:MAXHR,HTLEV),
     *WNDU(MINHR:MAXHR,HTLEV),WNDV(MINHR:MAXHR,HTLEV),
     *SIGW(MINHR:MAXHR,HTLEV),SIGV(MINHR:MAXHR,HTLEV)
C
C DATA DICTIONARY:
C    VARIABLE               DESCRIPTION
C***SURFACE SCALING FACTORS
C   Z0(HR)          SURFACE ROUGHNESS PARAMETER (M)
C   USTAR(HR)       SURFACE FRICTION VELOCITY (M/S)
C   HSF(HR)         SURFACE HEAT FLUX DENSITY (W/M**2)
C   MOL(HR)         MONIN-OBUKHOV LENGTH (M)
C***MIXING HEIGHTS
C   ZICONV(HR)      CONVECTIVE ESTIMATE OF MIXING HEIGHT (M)
C   ZIMECH(HR)      MECHANICAL ESTIMATE OF MIXING HEIGHT (M)
C   ZI(HR)          MIXING HEIGHT (M)  (MAX. OF ABOVE 2 VARIABLES)
C   ZHI(HR)         TEMPERATURE INVERSION HEIGHT (M)
C***PARAMETERS MEASURED AT MIXING HEIGHT
C   ZIPRES(HR)      PRESSURE (MB)
C   ZITEMP(HR)      TEMPERATURE (DEG. C)
C   ZIU(HR)         NORTH-SOUTH COMPONENT OF THE WIND (M/S)
C   ZIV(HR)         EAST-WEST COMPONENT OF THE WIND (M/S)
C   ZISW(HR)        VERTICAL WIND SPEED FLUCTUATIONS (M/S)
C   ZISV(HR)        HORIZONTAL WIND SPEED FLUCTUATIONS (M/S)
C***PROFILE VALUES
C   PRES(HR,LEV)     PRESSURE (MB)
C   TEMPS(HR,LEV)    TEMPERATURE (DEG. C)
C   WNDU(HR,LEV)     NORTH-SOUTH COMPONENT OF THE WIND (M/S)
C   WNDV(HR,LEV)     EAST-WEST COMPONENT OF THE WIND (M/S)
C   SIGW(HR,LEV)     VERTICAL WIND SPEED FLUCTUATIONS (M/S)
C   SIGV(HR,LEV)     HORIZONTAL WIND SPEED FLUCTUATIONS (M/S)
 END
C
C
C----------------------------------------------------------------
```

maximum number of profile heights

output meteorology - primary variables

Figure 7.1. Continued.

```
COMPRM  PROC
C
C..................................................................
C COMPRM - CONTAINS SELECTED COMPUTED PARAMETERS
C..................................................................
       REAL SUNANG,USRHTS,PROFHT
       INTEGER MHTS,MHGTS
       COMMON /COMPRM/ MHTS,USRHTS(HTLEV),MHGTS(MINHR:MAXHR),
      &PROFHT(MINHR:MAXHR,HTLEV),SUNANG(MINHR:MAXHR)
C
C DATA DICTIONARY:
C     VARIABLE              DESCRIPTION
C    SUNANG(HR)      SOLAR ELEVATION (DEGREES)
C    USRHTS(HT)      USER SELECTED ARRAY OF HEIGHTS
C    MHGTS(HR)       USER SPECIFIED NUMBER OF PROFILE HEIGHTS (= MHTS)
C    PROFHT(HR,LEV)  PROFILE HEIGHTS COMPUTED (M)
C    MHTS            NUMBER OF PROFILE HEIGHTS PROVIDED BY THE USER
 END
C
C
C------------------------------------------------------------------
USRPRM  PROC
C
C..................................................................
C USRPRM - CONTAINS THE USER SELECTED MODELS FOR EXECUTION
C..................................................................
        INTEGER FSELN,DYBU,ZOMOD,HMOD,USMOD,LMOD,ZICMOD,
      &  ZIMMOD,HTMOD,TMPMOD,UVMOD,SWMOD,SVMOD
      &  ,OUTMOD
C
       COMMON /USRPRM/FSELN,DYBU,ZOMOD,HMOD,USMOD,LMOD,ZICMOD,ZIMMOD,
      & HTMOD,TMPMOD,UVMOD,SWMOD,SVMOD,OUTMOD
C
C DATA DICTIONARY:
C     VARIABLE              SELECTION VARIABLE FOR:
C    ZOMOD           SURFACE ROUGHNESS LENGTH
C    HMOD            SURFACE HEAT FLUX
C    USMOD           SURFACE FRICTION VELOCITY
C    LMOD            MONIN-OBUKHOV THEORY
C    DYBU            DYER OR BUSINGER SIMILARITY CONSTANTS
C    ZICMOD          CONVECTIVE MIXING HEIGHT
C    ZIMMOD          MECHANICAL MIXING HEIGHT
C    HTMOD           HEIGHT
C    TMPMOD          TEMPERATURE PROFILE
C    UVMOD           WIND PROFILE
C    SWMOD           VERTICAL WIND FLUCTUATION PROFILE
C    SVMOD           HORIZONAL WIND FLUCTUATION PROFILE
C    OUTMOD          OUTPUT STYLE
C    FSELN           SURFACE SIMILARITY FUNCTION - STABLE CASE
 END
C
C
```

output meteorology - secondary variables

variables for metprocessor execution (see Table 4.17, Section 4)

Figure 7.1. Continued.

Driver

The functions of the DRIVER program and their relation to its structure are illustrated in Figure 7.2. The primary functions of DRIVER are to read data (steps 5 and 6 in Figure 7.2) and to CALL subroutines containing the methods that compute parameters and construct profiles (steps 8-12 in Figure 7.2). Secondary functions include initializing variables, selecting a mixing height, and issuing a final report.

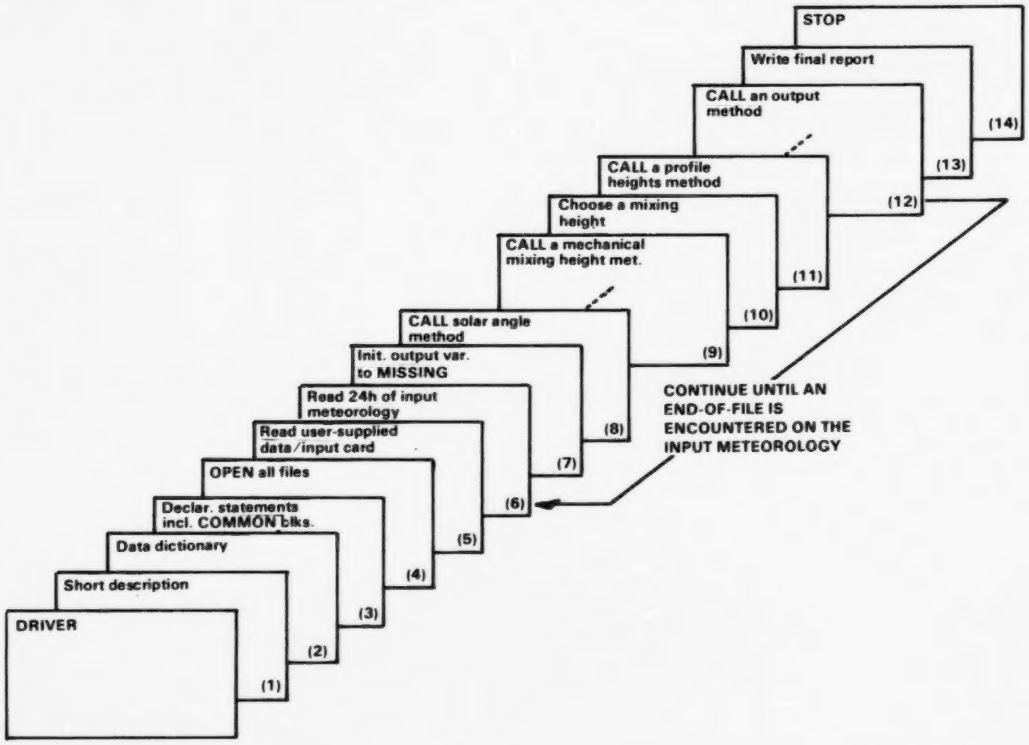

STOP
Write final report
CALL an output method
CALL a profile heights method
Choose a mixing height
CALL a mechanical mixing height met.
CALL solar angle method
Init. output var. to MISSING
Read 24h of input meteorology
Read user-supplied data/input card
OPEN all files
Declar. statements incl. COMMON blks.
Data dictionary
Short description
DRIVER
(1)
(2)
(3)
(4)
(5)
(6)
(7)
(8)
(9)
(10)
(11)
(12)
(13)
(14)
CONTINUE UNTIL AN END-OF-FILE IS ENCOUNTERED ON THE INPUT METEOROLOGY

Figure 7.2. The primary functions of DRIVER and their relation to its structure.

DRIVER reads the user-supplied data (step 5 in Figure 7.2) from the input card. This card defines the methods to be used to compute the atmospheric parameters and variables in the metprocessor and the heights at which variables in the profiles are to be computed. The variables representing the methods selected are retained in the COMMON block USRPRM. The format of the input card for DRIVER is given in Section 4.

After the user-supplied data are read, a loop is started to read the merged input meteorology (attached to logical file 25) and to implement the methods selected. One day (24 h) of merged data is read (step 6) and before executing any of the methods, all output variables are initialized to the missing value indicator. Each method is then called in the order given in Figure 2.3 (Section 2), and 24 hourly values of a parameter or profile variable are entered into the output meteorology COMMON blocks METOUT and COMPRM.

After the mixing height is computed (step 10), the metprocessor continues with the profile computations and finishes with an output routine (step 12) to write the information contained in METOUT and COMPRM to an output file (attached to logical file 8). Each 24-h period is processed in an identical manner until the EOF on the input meteorology is read, at which time a final report is written (step 13) and the metprocessor stops.

Accessing the Methods of Calculation

The CALLs to the methods are grouped in the DRIVER according to the parameter or profile they compute, and each group has a selection variable name. For example, all the CALLs for the surface heat flux methods are grouped together; the selection variable name is HMOD (Table 4.17 in Section 4 gives all the selection variables).

A method for the group is executed by selecting the integer constant corresponding to the method desired (also in Table 4.17) and by placing the constant in the correct position on the input card (order is given in

Table 4.17). For example, there are three ways to compute the surface heat flux. To execute HMOD1, the required integer constant on the input card is 1; to execute HMOD3, the integer constant is 3; to execute HMOD4, the integer constant is 4. There is no HMOD2 in the MPDA-1, because as new methods are found, old routines are discarded. Thus, the numerical sequence may be broken. For each run, only one of these methods can be selected, and the constant must appear in the fourth position in the list-directed READ.

The Subroutines

The framework for each subroutine for the methods of calculation has been standardized and consists of the elements shown in Figure 7.3 and described below.

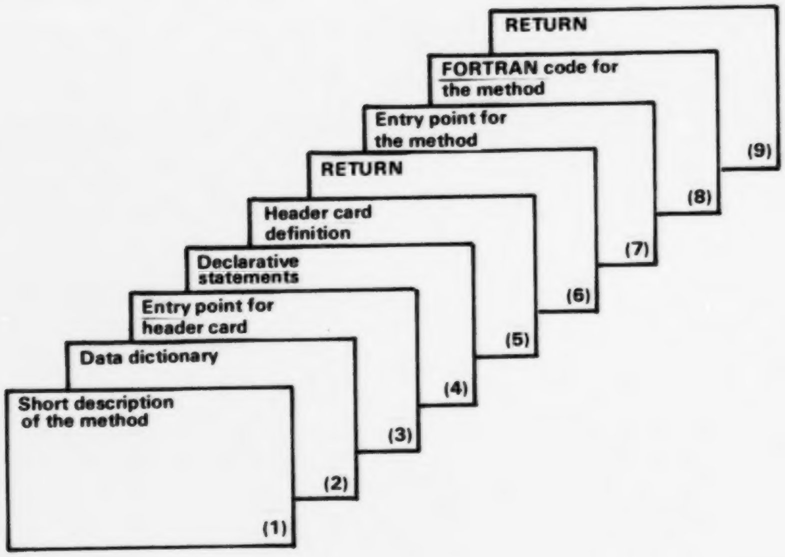

RETURN
FORTRAN code for the method
Entry point for the method
RETURN
Header card definition
Declarative statements
Entry point for header card
Data dictionary
Short description of the method
(9)
(8)
(7)
(6)
(5)
(4)
(3)
(2)
(1)

Figure 7.3. Design of the subroutines for the methods of calculation in the metprocessor.

1. Description of the method: A short description of the method, including its function and pertinent references is given.
2. Data dictionary: The variables and other routines specific to the subroutine are defined.
3. Entry point for the header card: This is the entry point for processing the descriptive header associated with a subroutine. Header information is processed by an output subroutine. The form of the entry point is as follows:

   SUBROUTINE pMnH(CARD),

   where p = parameter or profile being computed,
   M = abbreviation for method,
   n = method number,
   H = abbreviation for header,
   CARD = subroutine argument for the header definition.
4. Declarative statements: All the variables are dimensioned and their types are declared. The COMMON blocks appear here.
5. Header card definition: Two 36-character strings are used to define the descriptive header. These two strings are equivalenced to a 72-character string (HEAD).
6. RETURN: End processing of the header definition.
7. Entry point for the method: DRIVER CALLs this entry point if the method was selected by the user. The entry point is of the following form:

   ENTRY pMODn,

   where p = parameter or profile being computed,
   MOD = abbreviation for model (equivalent to method),
   n = method number.

8. Method: This is the source code for the method used to compute a parameter or construct a profile. The code is well-commented and describes each step clearly.
9. RETURN: The parameter or profile has been computed for each hour of the day and entered into the output COMMON blocks. Control is returned to DRIVER.

ADDING METHODS

To add your own method of computing an existing parameter or profile for the metprocessor, follow three steps:

1. Code the method according to the general structure described previously (Figure 7.3). Changes to existing code may be facilitated by using parts of an existing subroutine and editing the appropriate portions.
2. Add a CALL in DRIVER to the method in the appropriate group, and use the appropriate selection variable name. The form of the CALL is as follows:

```
IF (pMOD .EQ. integer constant for the method) CALL method name
```

The selection variable name and integer constant are described earlier in this section.

3. Add a CALL in the output subroutines to the header card definition entry point of the new method. The form of the call is as follows:

```
IF (pMOD .EQ. integer constant for the method) CALL header entry point
```

TABLE 7.5. INSTALLATION CHECKLIST FOR PRODUCING EXECUTABLE CODE

	Steps	User Notes
1.	Retrieve each of the 3 program files (MPDAPRE., MPDALIB., MPDACODE1.) and the PROC file (MPDAMPROCS.) from the tape. The contents of each file are shown in Table 7.2.	
2a.	Separate the programs and subroutines into individual files. On a UNIVAC, the program files can be recreated as discussed under the heading called Configuration of MPDA Files on the NTIS Tape, in this section.	
2b.	Separate the PROCs (which contain the COMMON blocks) and modify the programs and subroutines, according to your system's requirements, to include the COMMON blocks. On a UNIVAC, the PROCs can be recreated as discussed under the heading called Configuration of MPDA Files on the NTIS Tape, in this section. Also see the discussion on nonstandard FORTRAN in this section.	
3.	Compile each of the programs and subroutines. The nonstandard ASCII FORTRAN declarative statements NAMELIST and INCLUDE, discussed under the heading called Problems With Executing the System in this section, are used in many of the programs and subroutines.	
4.	Collect and link the compiled subroutines to the main programs. The subroutines required by each of the main programs are shown in Table 7.3. A brief description of the function of each subroutine is provided in Table F.1 in Appendix F. (NOTE: The procedure of collecting and linking is referred to as mapping on a UNIVAC and linking on an IBM and DEC VAX.)	
5.	The programs are now ready to execute as shown in the runstreams in Section 5. A checklist to run the system is provided at the end of Section 5.	

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APPENDIX A

COMPUTATION OF THE SOLAR ELEVATION ANGLE

SOLANG is the name of the subroutine that calculates the solar elevation angle (SUNANG). SUNANG is used by a number of subroutines, including HMOD3, OUT3 (reports the value), USMOD3, ZCMOD1, and ZCMOD2.

The formula for solar elevation (ϕ), derived using spherical trigonometry, is a function of an observer's latitude (ψ), solar declination (δ) and hour angle (h) given by the following equation:

$$\sin \phi = \sin \delta \sin \psi + \cos \delta \cos \psi \cos h \qquad \text{(A-1)}$$

The hour angle is the angle through which the earth must rotate to bring the observer's meridian directly below the sun, and declination is the angular distance north or south of the celestial equator.

Holtslag and van Ulden (1983) have provided formulas for computing δ and h, which are a function of solar longitude (SL). The solar longitude is determined by the following equation:

$$\text{SL(radians)} = 4.871 + 0.0175 \times \text{JDATE} + 0.033 \sin (0.0175 \times \text{JDATE}) \qquad \text{(A-2)}$$

where JDATE is the Julian date and all the coefficients are in radians. The declination is then computed by the following equation:

$$\delta \text{ (radians)} = \arcsin [0.398 \sin (\text{SL})] \qquad \text{(A-3)}$$

and hour angle by this equation:

$$h\text{(radians)} = -\lambda_W + 0.043\sin(2\ \text{SL}) - 0.033 \sin(0.0175 \times \text{JDATE}) + 0.262t - \pi, \qquad \text{(A-4)}$$

where λ_W is the observer's longitude, defined as positive west of Greenwich, and t is GMT in hours (0-23). These results and the observer's latitude are used in (A-1) to compute solar elevation. This approximation for ϕ is accurate to within 0.05 radians of the actual value.

The computations above are valid for the northern hemisphere. For the southern hemisphere the declination is defined as negative, i.e.,

$$\delta = - \arcsin [0.398 \sin (SL)] \qquad \text{(A-5)}$$

and the computations proceed as for the northern hemisphere.

APPENDIX B

COMPUTATION OF THE CRITICAL SOLAR ELEVATION ANGLE

The critical solar elevation angle (ϕ_0) occurs when heat flux becomes zero. Holtslag and van Ulden (1983) found that $\phi_0 = 13°$ for $N \leq 0.75$, and ϕ_0 increases to 23° for $N = 1.0$. Equation (9b) in Section 3 is solved for Q^*, with $H_0 = 0$ and the empirical expression for δ/s. Equation (10) in Section 3 is then rearranged to give an expression for ϕ_0:

$$\phi_0 = \left\{\arcsin\left[\frac{(1 + c_3)Q^* - c_1\, T^6 - c_2 N + \sigma T^4}{(1 + b_1 N^{b_2})(1 - r)}\right] - a_2\right\}/a_1$$

All the coefficients are the same as in (10).

APPENDIX C

FILE FORMAT REQUIREMENTS FOR MID-SEQUENCE PROGRAMS

Tables C.1 through C.9 contain file format requirements for the programs that occur after the first program in a data pathway. If the user begins with the first program in a sequence, he will not need to refer to these tables, because the format requirements are identical for all programs in a data pathway. If the user enters the pathway after the initial program in the sequence, he can refer to the tables in this appendix for the format requirements of the program of interest. The user should consult Section 4 for the logical file numbers associated with these input file formats.

A file is constructed by creating the number of records indicated for each record type. The format of the record type is determined by stringing together the formats of each variable in the record type. For example in Table C.1, for record type 4 there are NLVL records, each with the format 6F8.1, 2I2. In all the files, one or more of the record types is repeated for the remainder of the records in the file.

TABLE C.1. INPUT FILE FORMAT FOR CONVERT-UPPR

Record Type	Number of Records	Variable(s)	Description	Units	Format/Type
1	1	IDEM1	Number of descriptive header records to follow (if there are none, a zero must be specified)	—	1X,I3
2	IDEM1	STRING	Descriptive headers	—	A72
3**	1	JYR, JMO JDA, JHR	Year (last two digits), month, day, hour	GMT*	4I2
		ISTAT	Station identifier	—	I6
		ALONG	Station longitude	decimal degrees	A6
		NLVL	Number of levels in the radiosonde report	—	I3
4**	NLVL	PRESS	Atmospheric pressure	mb	F8.1
		HIGHT	Height above mean sea level	m	F8.1
		TEMP	Temperature	°C	F8.1
		RLHUM	Relative humidity	%	F8.1
		WINDR	Wind direction from north	degrees	F8.1
		WINSP	Wind speed	m/s	F8.1
		HGTIN	Flag indicating a measured or computed value	—	I2
		TMPIN	Same as HGTIN except it is for temperature	—	I2

* Greenwich Mean Time.

** The format established by record types 3 and 4 is repeated for all the radiosonde reports.

TABLE C.2. INPUT FILE FORMAT FOR QA-UPPR: OPTION 1

Record Type	Number of Records	Variable(s)	Description	Units	Format/Type
1	1	IVERS	Number of descriptive header records to follow	—	1X,I3
2	IVERS	FILEHD	Descriptive headers	—	A132
3*	N	IY, IM, ID, IH	Year, month, day, hour	LST	4I2
		ISTA	Station identifier	—	I6
		STNLON	Station longitude	decimal degrees	A6
		I	Record number for current radiosonde	—	I3
		N	Total number of records in the radiosonde report	—	I3
		P	Pressure	mb	F8.1
		H	Height above mean sea level	m	F8.1
		T	Temperature	°C	F8.1
		TD	Dew point	°C	F8.1
		WD	Wind direction	degrees from north	F8.1
		WS	Wind speed	m/s	F8.1

* The record format of record type 3 is repeated for all records in the current sounding and all subsequent soundings.

TABLE C.3. INPUT FILE FORMAT FOR QA-UPPR: OPTION 2

Record Type	Number of Records	Variable(s)	Description	Units	Format/Type
1	1	IVERS	Number of descriptive header records to follow (if there are none, a zero must be specified)	–	1X,I3
2	IVERS	FILEHD	Descriptive headers	–	A132
3*	1	IY, IM, ID, IH	Year (last two digits), month, day, hour	LST	4I2
		ISTA	Station identifier	–	I6
		STNLON	Station longitude	decimal degrees	A6
		N	Number of levels in the radiosonde report	–	I3
4*	N	P	Pressure	mb	F8.1
		H	Height above mean sea level	m	F8.1
		T	Temperature	°C	F8.1
		TD	Dew point	°C	F8.1
		WD	Wind direction	degrees from north	F8.1
		WS	Wind speed	m/s	F8.1

* The format established by record types 3 and 4 is repeated for all of the radiosonde reports

TABLE C.4. INPUT FILE FORMAT FOR REDUCE

Record Type	Number of Records	Variable(s)	Description	Units	Format/Type
1	1	IDEM1	Number of descriptive header records to follow (if there are none, a zero must be specified)	—	1X,I3
2	IDEM1	STRING	Descriptive headers	—	A72
3*	1	IYRIN, IMOIN, IDAIN, IHRIN	Year (last two digits) month, day, hour	LST	4I2
		ISTIN	Station identifier	—	I6
		LONIN	Station longitude	decimal degrees	A6
		LEVIN	Number of levels in the input radiosonde report	—	I3
4*	LEVIN	PRESIN	Atmospheric pressure	mb	F8.1
		HGTIN	Height above mean sea level	m	F8.1
		TMPIN	Temperature	°C	F8.1
		DWPIN	Dew point	°C	F8.1
		WDRIN	Wind direction	degrees from north	F8.1
		WSPIN	Wind speed	m/s	F8.1

* The formats established by record types 3 and 4 are repeated for the remaining radiosonde reports.

TABLE C.5. INPUT FILE FORMAT FOR HRLY-INTERP

Record Type	Number of Records	Variable(s)*	Description	Units	Format/Type
1	1	IDEM1	Number of descriptive header records to follow (if there are none, a zero must be specified)	—	1X,I3
2	IDEM1	STRING	Descriptive headers	—	A72
3*	1	IDATE(1,M)	Year (last two digits)	LST	
		IDATE(2,M)	Month		
		IDATE(3,M)	Day		4I2
		IDATE(4,M)	Hour		4I2
		ISTAT(M)	Station identifier	—	I6
		ALONG(M)	Station longitude	decimal degrees	A6
		NLVL(M)	Number of levels in the radiosonde report	—	I3
4*	NLVL	SK(1,N,M)	Atmospheric pressure	mb	F8.1
		SK(2,N,M)	Height above mean sea level	m	F8.1
		SK(3,N,M)	Temperature	°C	F8.1
		SK(4,N,M)	Dew point	°C	F8.1
		SK(5, N,M)	Wind direction	degrees from north	F8.1
		SK(6,N,M)	Wind speed	m/s	F8.1

* The subscripts M and N refer to the radiosonde report and the report level, respectively. As before, all subsequent radiosonde reports repeat the pattern established by record types 3 and 4.

TABLE C.6. INPUT FILE FORMAT FOR CONVERT-SFC

Record Type	Number of Records	Variable(s)	Description	Units	Format/Type
1	1	IDEM	Number of descriptive header records to follow (if there are none, a zero must be specified)	—	1X,I3
2*	IDEM	—	Descriptive headers	—	A72
3*	1	ISTNO	Station identifier	—	1X,I5.5
		IYR, IMO, IDA, IHR	Year (last two digits), month, day, hour	LST	4(1X,I2)
		STLAT, STLON	Station latitude and longitude	decimal degrees	2F8.2
4*	1	PRESSO	Station pressure reduced to sea level	mb	F8.2
		DRYTMP	Ambient air temperature	°F	F8.2
		WETTMP	Wet bulb temperature	°F	F8.2
		DEWPT	Dew point	°F	F8.2
		WDIR	Wind direction	degrees from north	F8.2
		WSP	Wind speed	knots	F8.2
		STAPR	Station pressure	inches of Hg	F8.2
		RH	Relative humidity	%	F8.2
5*	1	ICEIL	Ceiling height	hundreds of feet	1X,I4
		IVSBY	Horizontal visibility	mi.	1X,I4
		ISVRE	Severe weather code	—	1X,I4
		ILIQP	Liquid precipitation type	—	1X,I4
		IFRZPC	Frozen precipitation type	—	1X,I4
		IOBSVS	Obstructions of vision code	—	1X,I4
		ITSC	Total cloud cover	%	1X,I4
		OPAQUE	Opaque cloud amount	%	1X,I4
		FLCDC, SLCDC, TLCDC, FTLCDC	Type of clouds at four levels	—	4(4X,A16)

* Record types 2 through 5 are repeated for all the surface observation reports. Unlike the radiosonde reports, the number of records per report is fixed at three; values are reported hourly.

TABLE C.7. INPUT FILE FORMAT FOR QA-SFC

Record Type	Number of Records	Variable(s)	Description	Units	Format/Type
1	1	IVERS	Number of descriptive header records to follow (if there are none, a zero must be specified)	—	1X,I3
2	IVERS	FILEHD	Descriptive headers	—	A80
3*	1	IDENT	Station identifier	—	A6
		IYR, IMO, IDA, IHR	Year (last two digits), month, day, hour	LST	4I2
		SLAT	Station latitude	decimal degrees	F8.2
		SLON	Station longitude	decimal degrees	F8.2
		SLP	Station pressure reduced to sea level	mb	F7.1
		T	Temperature	°C	F7.1
		DP	Dew point	°C	F7.1
		WD	Wind direction	degrees from north	F7.1
		WS	Wind speed	m/s	F7.1
		PSTA	Station pressure	mb	F7.1
		ICEIL	Ceiling height	dm	I4
		IVIS	Horizontal visibility	hundreds of meters	I4
		ISVR	Severe weather code	—	I4
		ILIQP	Liquid precipitation type	—	I4
		IFRZP	Frozen precipitation type	—	I4
		IOBST	Obstructions to vision	—	I4
4*	1	ITC	Total cloud cover	%	I4
		IOC	Opaque cloud amount	—	I4
		LR1	First layer cloud data	—	A16
		LR2	Second layer cloud data	—	A16
		LR3	Third layer cloud data	—	A16
		LR4	Fourth layer cloud data	—	A16

* The format established by record types 3 and 4 are repeated for the remainder of the surface observations.

TABLE C.8. INPUT FILE FORMAT FOR RADIOSONDE DATA FOR MERGE

Record Type	Number of Records	Variable(s)	Description	Units	Format/Type
1	1	IHDRS	Number of descriptive header records to follow (if there are none, a zero must be specified)	—	1X,I3
2	IHDRS	STRING	Descriptive headers	—	A72
3*	1	IYR, MNTHRS, DAYRS, IHRRS	Year (last two digits), month, day hour	LST	4I2
		ISTRS	Station identifier	—	I6
		LONRS	Station longitude	decimal degrees	A6
		NLEVRS	Numbers of levels in the radiosonde report	—	I3
4*	NLEVRS	PRESS	Atmospheric pressure	mb	F8.1
		HIGHT	Height above mean sea level	m	F8.1
		TEMP	Temperature	°C	F8.1
		DEWPRS	Dew point	°C	F8.1
		WINDR	Wind direction	degrees from north	F8.1
		WINSP	Wind speed	m/s	F8.1

* The pattern established by record types 3 and 4 is repeated for all subsequent radiosonde reports.

TABLE C.9. INPUT FILE FORMAT FOR SURFACE OBSERVATIONS FOR MERGE

Record Type	Number of Records	Variable(s)	Description	Units	Format/Type
1	1	IHDSO	Number of descriptive header records to follow (if there are none, a zero must be specified)	—	1X,I3
2	IHDSO	STRING	Descriptive headers	—	A72
3*	1	ISTNO	Station identifier	—	I6
		IYRSO, IMOSO, IDASO, IHRSO	Year (last two digits) month, day, hour	LST	4I2
		STLAT, STLON	Station latitude and longitude	decimal degrees	2F8.2
		PRESSO	Station pressure reduced to sea level	mb	F7.1
		DRYTMP	Ambient air temperature	°C	F7.1
		DEWPT	Dew point	°C	F7.1
		WDIR	Wind direction	degrees from north	F7.1
		WSP	Wind speed	m/s	F7.1
		STAPR	Station pressure	mb	F7.1
		ICEIL	Ceiling height	dm	I4
		IVSBY	Horizontal visibility	hundreds of meters	I4
		ISVRE	Severe weather code	—	I4
		ILIQPC	Liquid precipitation type	—	I4
		IFRZPC	Frozen precipitation type	—	I4
		IOBSVS	Obstructions to vision code	—	I4
4*	1	ITSC	Total cloud cover	%	I4
		OPAQUE	Opaque cloud amount	%	I4
		FLCDC, SLCDC, TLCDC, FTLCDC	Cloud type at four levels	—	4(A16)

* The pattern established by record types 3 and 4 is repeated for all subsequent reports.

APPENDIX D

OUTPUT FILE FORMAT FROM OUT4

OUT4 writes the meteorological output from the metprocessor for use by TUPOS. The file produced for TUPOS contains unformatted descriptive headers and data records. Table D.1 illustrates the output file format of OUT4.

TABLE D.1. OUTPUT FILE FORMAT OF OUT4

Record Type	Number of Records	Variable(s)	Description	Units	Format/Type
1	1	CRDNUM	Number of descriptive headers to follow	—	I
2	CRDNUM	STRING	Descriptive headers	—	C * 72
3*	1	IYR	Last 2 digits of the year	—	I
		JDATE	Julian date	—	I
		HR	Hour	—	I
		NLLIM	Number of levels in profile, including mixing height		
		LMX	Level corresponding to mixing height	—	I
		KLASS	Stability index: determined from Monin-Obukhov length, mixing height, and surface wind speed	—	I
		ZL	Height of profile level	m	R
		TL	Temperature	K	R
		WDL	Wind direction	degrees from north	R
		UL	Wind speed	m/s	R
		SAL	Horizontal wind fluctuation	radians	R
		SEL	Vertical wind fluctuation	radians	R

* The format established by record type 3 is repeated for all the data.

The TUPOS diffusion model requires the data to be on a 1-24 hour clock. The current version of the MERGE and metprocessor use a 0-23 hour clock. The user has two options to correct this discrepancy: (1) change MINHR and MAXHR in the DAYMET PROC from 0 and 23 to 1 and 24, respectively, and recompile all the metprocessor routines and MERGE, or (2) make no changes and allow OUT4 to redefine the hours automatically, i.e., hour 1 remains as hour 1, hour 2 as hour 2,..., hour 23 as hour 23, but hour 24 is hour 0 of the next day. If the user chooses option 1, then option 2 will automatically be skipped in OUT4.

APPENDIX E

ERROR MESSAGES

Programs in the MPDA-1 can generate a number of error messages. The following tables (E.1 - E.8) provide a list of those messages and their significance. The tables are organized by program type (e.g., SCAN, QA) and are arranged according to the order in which they are executed.

TABLE E.1. ERROR MESSAGES THAT CAN OCCUR IN THE SCAN PROGRAMS

Error Message	Description
ERROR IN OPENING FILE, IOST =	This input or output file was not opened properly. The logical file number attached to the file and IOSTAT value are printed, and the program stops.
ERROR IN INPUT CARD READ, IOST =	The user-supplied value on the input card was not read correctly. The IOSTAT value is printed, and the program stops.
ERROR IN INQUIRE, IOST = DEVICE =	An INQUIRE on the name of the file attached to the logical file number printed failed. The IOSTAT value is also printed, and the program stops.
ERROR FROM ATAPE, IOST =	The reading of the hourly observations by ATAPE failed. The IOSTAT value is printed, and the program stops.
* ERROR IN DECODE; ERROR OCCURED IN BLOCK IN RECORD , IOST =	An internal READ of the station ID and date failed. The internal file specifier is one of the 80-character hourly observations. The IOSTAT value position on tape and internal file specifiers are printed, and processing continues with the next record.
† ERROR AT STRING DECODE, IOST =	An internal READ failed. The internal file specifier is the 25-character string containing the header information. The IOSTAT value is printed, and the program continues with the next record.

* Occurs only in SCAN-SFC.
† Occurs only in SCAN-UPPR.

TABLE E.2. ERROR MESSAGES THAT CAN OCCUR IN THE EXTRACT PROGRAMS

Error Message	Description
ERROR IN OPENING FILE , IOST =	The input or output file was not opened properly. The logical file number attached to the file and IOSTAT value are printed, and the program stops.
ERROR IN INPUT CARD READ, IOST =	The user-supplied values on the input card were not read correctly. The IOSTAT value is printed, and the program stops.
† ERROR IN INQUIRE, IOST = DEVICE =	An inquiry on the name of a file attached to a logical file number failed. The IOSTAT value and file number are printed, and the program stops.
ERROR FROM ATAPE, IOST =	The reading of the data by subroutine ATAPE failed. The IOSTAT value is printed, and the program stops.
† BAD IOSTAT AT HEADER STRING READ =	An internal READ failed. The internal file specifier is the 25-character string that contains the header information. The IOSTAT value and file specifier are printed, and the program continues with the next report.
† BAD IOSTAT AT STRING READ =	An internal READ failed. The internal file specifier is one of the 25-character strings containing one level of data. The IOSTAT value, header, and file specifier are printed, and the program continues with the next level.
* ERROR IN DECODE; ERROR OCCURRED IN BLOCK IN RECORD , IOST2 =	An internal READ of the station ID and date failed. The internal file specifier is one of the 80-character hourly observations. The IOSTAT value position on the tape, and the first 13 characters of the specifier are printed, and processing continues with the next record.
* ERROR IN DECODE; ERROR OCCURED IN BLOCK IN RECORD, IOST3 =	An internal READ of the surface data failed. The internal file specifier is one of the 80-character hourly observations. The IOSTAT value, position on the tape, and file specifier are printed, and processing continues with the next record.
ERROR IN SKY DECODE, IOST = STRING SKY =	An internal READ from a string specifier for sky conditions failed. The IOSTAT value, station, and date and string specifier are printed, and processing continues with next record.

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* Occurs in EXTRACT-SFC

† Occurs only in EXTRACT-UPPR.

TABLE E.3. ERROR MESSAGES THAT CAN OCCUR IN THE CONVERT PROGRAMS

Error Message	Description
INPUT CARD READ ERROR, IOST =	The list-directed READ of the input card was not read properly. The message and IOSTAT value are printed, and the program stops.
ERROR IN OPENING FILE, IOST =	An input or output file was not opened correctly. The device number attached to the file and IOSTAT value are also printed, and the program stops.
† ERROR AT IDEM1 HDR READ, IOST =	The number of descriptive headers (IDEM1) was not read correctly. The message and IOSTAT value are printed, and the program stops.
† ERROR AT STRING DESC. HEADER, IOSTAT =	One of the descriptive headers was not read correctly. The IOSTAT value is printed, and the program stops.
† ERROR AT STRING/VERSN ENCODE =	An internal READ failed. The internal file specifier is the descriptive header read before the internal READ (above). The IOSTAT value is printed, and the program stops.
† HEADER READ ERROR, IOST1 =	The radiosonde header (with the station identifier, date and time, etc.) was not read properly. The IOSTAT value is printed, and the program stops.
† ERROR AT LEVEL READ, IOST =	A line of the radiosonde report was not read properly. The IOSTAT value is printed, and the program stops.
* ERROR AT FIRST CARD, DEVICE = IOST =	The number of descriptive headers was not read correctly. The message and IOSTAT value are printed, and the program stops.
ERROR AT DECODE HDR. READ, IOST =	One of the descriptive headers was not read correctly. The message and IOSTAT value are printed, and the program stops.
ERROR — BAD IOST FROM RECORD READ =	A surface observation record was not read correctly. The message and IOSTAT value are printed, and the program stops.

* Occurs only in CONVERT-SFC.
† Occurs only in CONVERT-UPPR.

TABLE E.4. ERROR MESSAGES THAT CAN OCCUR IN THE QA PROGRAMS

Error Message	Description
† PRESSURE INVERTED FOR LEVEL =	The pressure values in the radiosonde report are in ascending order. The year, month, day, hour, station identifier, and level are printed; the program continues with the next radiosonde report.
† MISSING OR INVALID INPUT FORMAT CODE	The input format specifier, IFORM, is missing or incorrectly specified. The programs stops.
† INPUT DATASET VERSION NUMBER EQUALS MAX VALUE	The maximum number of descriptive headers (20 is the current value) has been attained before the header from the QA program has been added. The program stops.
†† SFC. HEIGHT MISSING FOR	The height of the first level is missing. The station identifier and year, month, day, and hour are printed; the program stops.
†† TEMPERATURE MISSING FOR	The temperature at the first level is missing. The station identifier and year, month, day, and hour are printed; the program stops.
* DEW POINT MISSING FOR	The dew point at the first level is missing. The station identifier and year, month, day, and hour are printed; the program stops.
* SFC. TEMP MISSING FOR	Temperature at the first level is missing. The station identifier and year, month, day, and hour are written; the program stops.
* SFC. TDEW MISSING FOR	The dew point at the first level is missing. The station identifier and year, month, day, and hour are written; the program stops.
* SOUNDING TRUNCATED AT LEVEL FOR MISSING TEMPS	The temperature values at the level printed and at all levels above it are missing. Missing temperatures above this level cannot be estimated; the program continues.
* SOUNDING TRUNCATED AT LEVEL FOR MISSING TDEWS	Dew point values at the level printed and at all levels above it are missing. Missing dew points above this level cannot be estimated; the program continues.
**ERROR IN OPENING FILE, IOST =	A problem occurred opening an input or an output file. The logical file number and IOSTAT value are printed, and the program stops.
**ERROR IN INPUT CARD READ, IOST =	The counter for the number of descriptive header records on the input file was not read correctly. The IOSTAT value is printed, and the program stops.
**ERROR AT HEADER RECORD, IOST =	A descriptive header record was not read correctly. The record number and IOSTAT value are printed, and the program stops.

continued

TABLE E.4. ERROR MESSAGES THAT CAN OCCUR IN THE QA PROGRAMS (CONTINUED)

Error Messages		Description
OPTIONS READ ERROR IOSTAT=		An option to assess a variable was not read correctly. The string describing the variable where the error occurred and the IOSTAT value are printed, and the program stops.
ERROR IN IDEM READ, IOST3 =		The number of descriptive headers (IDEM) was not read correctly from the on-site data file. The IOSTAT value is printed, and the program stops. This message is issued from subroutine DESHDR.
ERROR IN STRING READ, IOST =		One of the descriptive headers in the on-site data file was not read correctly. The IOSTAT value is printed, and the program stops. This message is issued from subroutine DESHDR.
**ERROR READING SCALARS, IOST =		The surface parameters z_0, u_*, H_0, and mixing height z_i were not read correctly. The IOSTAT value is printed, and the program stops.
**ERROR READING A LEVEL OF DATA:	MONTH = DAY = LEVEL = IOSTAT =	A level of data was not read correctly. The month, day, number of the level, and IOSTAT value are printed, and the program stops.

† Occurs in QA-UPPR.
†† Occurs in QA-UPPR, subroutine HTCALC.
* Occurs in QA-UPPR, subroutine TDPEST.
** Occurs in QA-SITE.

TABLE E.5. ERROR MESSAGES THAT CAN OCCUR IN REDUCE

Error Message	Description
ERROR IN OPENING FILE, IOST =	A problem occurred in opening an input or output file. The logical file number attached to the file and IOSTAT are printed, and the program stops.
ERROR AT IDEM CARD, IOSTAT =	The number of descriptive headers in the input file was not read correctly. The IOSTAT value is printed, and the program stops.
ERROR AT STRING READ, IOSTAT =	A descriptive header was not read correctly. The IOSTAT value is printed, and the program stops.
ERROR AT VERSRN READ, IOSTAT =	An internal READ failed. The internal file specifier is the descriptive header read immediately before the internal READ. The IOSTAT value is printed, and the program stops.
ERROR READ INPUT PARAMETERS..IOST =	The list-directed READ of the input card failed. The IOSTAT value is printed, and the program stops.
ERROR AT HEADER RECORD READ..IOST	The first record in the radiosonde report was not read properly. The IOSTAT value is printed, and the program stops.
ERROR IN LEVEL READ..IOST8 =	One of the levels of data in a report was not read properly. The IOSTAT value is printed, and the program stops.
HEIGHT OF THE FIRST LEVEL IS LESS THAN ZERO	The height of the first radiosonde level is less than zero. The year, month, day, hour, and height are printed, the correction value is set to zero, and processing continues.

TABLE E.6. ERROR MESSAGES THAT CAN OCCUR IN HRLY-INTERP

Error Message	Description
ERROR IN INPUT CARD READ, IOST =	The list-directed READ of the input card failed. The IOSTAT value is printed, and the program stops.
ERROR IN OPENING FILE, IOST =	A problem occurred in opening an input or output file. The logical file number attached to the file and IOSTAT value are printed, and the program stops.
ERROR IN DESCRIPTIVE HDR, COUNT READ, IOST =	The number of descriptive headers in the input file was not read correctly. The IOSTAT value is printed, and the program stops.
ERROR IN READ STRING READ, IOST =	A descriptive header was not read correctly. The IOSTAT value is printed, and the program stops.
IOST ERROR IN RADIOSONDE HEADER READ	The first record in a radiosonde report was not read properly. The IOSTAT value is printed, and the program stops.
LEVEL READ I/O ERROR	One of the levels of data in a radiosonde report was not read properly. The variables in the record are printed, and the program stops.
MISSING DATA	An entire radiosonde report is missing. The first record of the next available report is printed; processing continues.
UNABLE TO REFINE, N =	Three attempts to reduce the number of levels to below 100 failed. The date and number of levels in the report are printed; processing continues.
MORE THAN 200 COMBINED LEVELS	The number of combined radiosonde levels exceeds 200. The message (issued from RALIGN) is written, and the program stops.

TABLE E.7. ERROR MESSAGES THAT CAN OCCUR IN MERGE

Error Message	Description
READ ERROR ON USER INPUTS	The user-supplied values on the input card were not read correctly. The IOSTAT value is printed, and the program stops.
READ ERROR ON USER TERRAIN INPUTS	The user-supplied terrain classes were not read properly. The IOSTAT value is printed, and the program stops.
ERROR IN OPENING FILE, IOST =	The input or output file was not opened properly. The logical file number attached to the file and IOSTAT value are printed, and the program stops. This message is located in subroutines OUTRPT and OUTUNF.
ERROR AT 1ST IDEM CARD, UNIT = IOST =	The count for the number of descriptive header records was not read correctly. The logical file number and IOSTAT value are printed, and the program stops. This message is located in subroutines OUTRPT and OUTUNF.
ERROR AT HEADER CARD, UNIT = IOST =	A descriptive header record was not read correctly. The logical file number and IOSTAT value are printed, and the program stops.
BAD RS HDR READ, IOST = AT REC =	The first informative header after the descriptive headers in the radiosonde input file was not read correctly. The IOSTAT value and record number are printed, and the program stops.
ERROR AT FIRST TOWER REC READ, IOST = AT RECORD =	The first informative header after the descriptive headers in the on-site input was not read correctly. The IOSTAT value and record number are printed, and the program stops.
ERROR READING HTS CARD, IOST = DEV =	One of the next nine on-site data records was not read correctly. The IOSTAT value and logical file number are printed, and the program stops.
ERROR AT FIRST SO RECORD READ, IOST = AT RECORD =	The first two records of the surface observations were not read correctly. The IOSTAT value and record number are printed, and the program stops.
TOO MANY LEVELS OF RS DATA—ARRAYS WILL OVERFLOW	The number of levels of radiosonde data (NLEV) exceeds the maximum number of levels (IRSLEV) that can be stored in the COMMON block DAYMET. The program stops before processing the levels.
I/O ERROR IN RS LEVEL READ	One of the levels in the radiosonde report was not read correctly. The IOSTAT value is printed, and the program stops.
ERROR AT RS HEADER READ, IOST = AT RECORD =	A subsequent informative header in the radiosonde file was not read correctly. The IOSTAT value and record number are printed, and the program stops.
ERROR IN RS RECORD READ, IOST = AT RECORD =	A subsequent informative header in the radiosonde file was not read correctly. The IOSTAT value and record number are printed, and the program stops.
ERROR IN TOWER RECORD READ, IOST = AT RECORD =	A subsequent informative header in the on-site input file was not read correctly. The IOSTAT value and record number are printed, and the program stops.
ERROR AT SO RECORD READ, IOST = AT RECORD =	Subsequent records of the surface weather observations were not read correctly. The IOSTAT value and record number are printed, and the program stops.

TABLE E.8. WARNING MESSAGES IN THE METPROCESSOR*

Message Number	Description
01	Error in reading the number of header cards on the input file. The IOSTAT value is printed, and processing stops.
12	Data are missing. The value cannot be computed for the hour; continue with the next hour. 12A: Parameter or profile variable to have been computed by the metprocessor is missing. 12B: Radiosonde data are missing 12C: Surface weather observations are missing. 12D: On-site data are missing.
13	Terrain parameters are missing or outside allowable range. Surface roughness length cannot be computed; use default value for all hours of the day; continue processing.
14	Data are missing. The variable at a profile height cannot be computed; continue with the next level. 14A: Parameter or profile variable to have been previously computed by the metprocessor is missing. 14B: Radiosonde data are missing. 14C: Surface weather observations are missing. 14D: On-site data are missing.
15	Data are missing. The hourly convective mixing heights cannot be computed; continue with the next day. 15B: Sunrise and sunrise + 12 h radiosonde data are missing. 15C: Surface observation data are missing.
16	Data are missing. Monin-Obukhov length (L) cannot be computed for the hour; set L to -9999.; continue with the next hour. 16A: Surface heat flux or friction velocity is missing. 16C: Surface temperature or pressure is missing.
17	Mixing height is missing. Cannot compute heights for the hour (HTMOD2); continue with the next hour.
21	Interpolation failure; non-zero flag returned; continue processing.
22	Solar elevation is always less than 0; no computation for the mixing height for the entire day; continue with the next method of calculation.
23	Atmospheric pressure for the radiosonde report corresponding to sunrise is never less than 700 mb; cannot compute convective mixing height for the entire day; continue with the next method of calculation.
24	Same as 23, except for the report corresponding to 12 h past sunrise.
25	Unable to interpolate data to initial convective mixing height for the entire day; continue with the next method of calculation.
26	Unable to interpolate data to convective mixing height; profile height is above highest radiosonde level; mixing height is set to highest radiosonde level; continue with the next hour.
27	Lowest level of the radiosonde report is not equal to zero; no convective mixing height is computed for the entire day; continue with the next method of calculation.
28	Monin-Obukhov length = 0, causing a division by 0; mechanical mixing height is set to missing (in ZMMOD2); continue with the next hour.

continued

TABLE E.8. WARNING MESSAGES IN THE METPROCESSOR* (CONTINUED)

Message Number	Description
31	Height of nonmissing level < 0.0 (UVMOD3); continue with the next hour. 31A: ZMIN < 0.0 31B: ZMAX < 0.0
32	Wind speed is zero; continue with the next hour.
33	On-site height > 100 z_0; use the on-site height in the computations; continue processing for the hour (HMOD1, USMOD1).
34	Mixing height < 0.0 but is not missing; stop processing.
35	Profile height < 0.0 but is not missing; continue with the next profile level.
36	Mixing height < first level of on-site data; continue with the next hour (SWMOD2, SVMOD2).

* Messages are in the following form: message number, method, Julian date, hour [,level, value]. The quantities in brackets are used only when a problem is encountered in a profile method.

APPENDIX F

TABLE F.1. SUBROUTINES USED IN THE PREPROCESSOR

Subroutine Name*	Description	Programs that CALL the Subroutine
ATAPE	Reads one physical record from magnetic tape (provided by the user; see Section 4 for further explanation)	SCAN-UPPR, EXTRACT-UPPR, SCAN-SFC EXTRACT-SFC
EBCASC	Converts EBCDIC character format to ASCII	SCAN-UPPR, EXTRACT-UPPR
GMTLST	Converts Greenwich mean time to local standard time	CONVERT-UPPR
P2MDP (P1MSUB)	Computes dew point from relative humidity and temperature	CONVERT-UPPR
GREG	Computes the Gregorian day from the Julian day	HRLY-INTERP, MERGE
SGNCHK	Checks for erroneous signs on temperature values of upper air data. Sign is changed, and dew point is recomputed	QA-UPPR
CHRON	Converts dates to the number of hours past the first hour of Jan. 1, 1960 (valid through 1999)	HRLY-INTERP
ADATE	Returns the system date and time to the program (a machine-dependent routine to be provided by the user)	QA-UPPR, QA-SFC, OUT4
RACHEK	Checks the validity of the data	QA-UPPR
ERRMSG	Writes error records and messages to logical file 11	QA-UPPR
HTCALC	Recomputes heights from pressure, temperature, and dew point	QA-UPPR
TDPEST	Estimates temperature and dew point if the values are not available and option TDPFIL is TRUE	QA-UPPR
UVCOMP	Computes u- and v- components of the wind from wind speed and direction	HRLY-INTERP
WDWSUV	Computes wind speed and direction from the u- and v-components of the wind	HRLY-INTERP
RALIGN	Aligns radiosonde reports so the heights are identical	HRLY-INTERP
SHRINK	Reduces the number of levels in a radiosonde report	HRLY-INTERP
FASMOV	Copies one array to another	HRLY-INTERP
P2MMTR (P2MSUB)	Converts hundreds of feet to decameters	CONVERT-SFC
P2MMM (P2MSUB)	Converts miles to hundreds of meters	CONVERT-SFC
P2MCEN (P2MSUB)	Converts degrees Farenheit to degrees Celsius	CONVERT-SFC
P2MMSC (P2MSUB)	Converts knots to meters per seconds	CONVERT-SFC
P2MMBR (P2MSUB)	Converts inches of mercury to millibars	CONVERT-SFC
DESHDR (TWRSUB)	Reads the descriptive headers from the input file and writes them to the output file	QA-SITE
HDR (TWRSUB)	From the input file, reads the informative header consisting of the date and time, and the number of heights of data	QA-SITE

continued

TABLE F.1. SUBROUTINES USED IN THE PREPROCESSOR (CONTINUED)

Subroutine Name*	Description	Programs that CALL the Subroutine
TALLYS	Reports the number of limit violations for each variable and parameter to the system's output logical file (6 on the UNIVAC)	QA-SITE
SCLRS (TWRSUB)	Reads the surface roughness length (z_0), mixing height (z_i), surface heat flux density (H_0), surface friction velocity, wind gust, liquid and solid precipitation amounts, snow depth, and sky conditions from the input file	QA-SITE
TWRLEV (TWRSUB)	Reads the levels of data from the input file	QA-SITE
READU9	Reads the options and limits for the variable	QA-SITE
WRHD8 (TWRSUB)	Writes the informative header to the output file	QA-SITE
WRHD10 (TWRSUB)	Writes the informative header to the violation report file	QA-SITE
WRSC8 (TWRSUB)	Writes z_0, h_m, H_0, and u_* to the output file	QA-SITE
WRSC10 (TWRSUB)	Writes z_0, h_m, H_0, and u_* to the violation report file	QA-SITE
WRLV8 (TWRSUB)	Writes the levels of data to the output file	QA-SITE
WRLV10 (TWRSUB)	Writes the violation report to the report file	QA-SITE
OUTRPT	Reads the descriptive header records from each input file and writes them to the formatted output file; CALLed only if WROPT is TRUE	MERGE
OUTUNF	Reads the descriptive header records from each input file and writes them to the unformatted output file	MERGE
IOCL**	Returns the input/output status of a READ/WRITE (a machine-dependent function)	All programs except QA-UPPR, QA-SFC, and MERGE
JULIAN**	Computes the Julian day from the Gregorian day; returns only the Julian date	SCAN-UPPR, EXTRACT-UPPR, CONVERT-UPPR, HRLY-INTERP, SCAN-SFC, EXTRACT-SFC, MERGE

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* Names in parentheses are the file elements that contain the subroutine as entry points.

** These are functions, rather than subroutines.

Date ______________________________

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